Effectiveness of combined surgical and exercise-based interventions following primary traumatic anterior shoulder dislocation: a systematic review and meta-analysis

Vaishnavi Chiddarwar,[1] Rutger M J de Zoete ,[2] Cameron Dickson,[2] Timothy Lathlean [3,4]

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[1]Texas Tech University Health Sciences Center, Lubbock, Texas, USA
[2]School of Allied Health Science and Practice, The University of Adelaide Faculty of Health and Medical Sciences, Adelaide, South Australia, Australia
[3]Adelaide Medical School, The University of Adelaide Faculty of Health and Medical Sciences, Adelaide, South Australia, Australia
[4]South Australian Health and Medical Research Institute Limited, Adelaide, South Australia, Australia

Correspondence to
Dr Timothy Lathlean, Adelaide Medical School, The University of Adelaide Faculty of Health and Medical Sciences, Adelaide, SA 5005, Australia; timothy.lathlean@adelaide.edu.au

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ABSTRACT

Objective To investigate the effectiveness, risk of recurrence and return to activity (RTA) of surgery combined with exercise-based interventions (EBI) versus EBI alone after traumatic anterior shoulder dislocation (ASD).

Design Systematic review and meta-analysis.

Data sources Systematic literature search (MEDLINE, Web of Science, Scopus, Google Scholar).

Eligibility Studies focused on EBI or EBI as a part of postoperative care for adults with an ASD, written in English, and published after 1990. We excluded diagnostic, assessment-based studies on individuals experiencing recurrent shoulder dislocations, concomitant shoulder injury, animal or cadaveric studies. Primary outcomes were dislocation RTA. Secondary outcomes were self-reported outcome measures, strength and range of motion. Random-effects meta-analysis was used to estimate the effect of EBI (SMD; Hedges' g, RR). The Grading of Recommendations Assessment, Development and Evaluation approach was used to assess the certainty of evidence.

Results Sixty studies were included (n=3598); seven were meta-analysed (n=345). The mean age of participants in the included studies was 26.71±9.19 and 56% of those included were male. Of the 60 studies included in the systematic review, 29 were fair quality (48.3%), 15 studies were good quality (25%) and 16 studies were poor quality (26.7%), (k=0.66). Individuals who underwent EBI alone were 2.03 times more likely to experience recurrent instability than individuals who underwent EBI in conjunction with surgery (RR 2.03, 95% CI 1.03 to 3.97). Individuals who underwent EBI with surgery appeared 1.81 times more likely to RTA than those who underwent EBI alone, although results were not statistically significant (RR 1.81, 95% CI 0.96 to 3.43).

Conclusions Surgery combined with EBI is more effective in reducing the risk of recurrence and possibly increasing RTA than EBI alone after traumatic ASD.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Primary traumatic anterior shoulder dislocation (ASD) is associated with complications and risk of recurrent instability.
⇒ Rehabilitation for ASD has primarily focused on postsurgical care.
⇒ The effectiveness of different types of exercise-based interventions (EBI) for ASD in comparison to surgical management plus EBI is unclear.

WHAT THIS STUDY ADDS

⇒ Surgery combined with EBI is more effective in reducing the risk of recurrence and possibly increasing return to activity when compared with EBI alone.
⇒ Stand-alone EBIs without shoulder surgery are effective in improving shoulder internal rotation strength and improving passive range of motion postinjury, with multimodal EBI demonstrating greater functional improvements.
⇒ The findings of this review are predominantly based on young male individuals who sustained a primary traumatic ASD in both athletic and non-athletic settings.
⇒ More research is needed to improve the quality of evidence informing EBI recommendations for ASD.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The key findings from this systematic review and meta-analysis help inform research, practice and policy by demonstrating the combined effectiveness of surgery and exercise-based interventions (EBI) following primary traumatic anterior shoulder dislocation (ASD).

INTRODUCTION

Dislocation of the glenohumeral joint refers to the complete loss of contact between the articulating surfaces of the glenoid and humeral head. This diagnosis is usually confirmed by radiography.[1] The overall incidence of primary traumatic anterior shoulder dislocation (ASD) in the UK is between 11 and 51 per 100 000 person-years.[2–4] The male incidence rate is 2.64 times higher than that of females, at 34.9 per 100 000 person-years.[4] Nearly 47.1% of ASD episodes occur between the ages of 20 and 29 years.[4] The frequency of instability, therefore, is inversely proportional to the age of an individual with a higher incidence in younger individuals.[5] Sixteen per cent of older individuals (ie, over 60 years) sustained an ASD from simple falls[6]; while ASD in younger individuals (less than 30 years) occurs predominantly in athletic settings.[6]

Table 1 A summary of the multicomponent rehabilitation protocols described in the included studies[9 33 34 55 97]

Stage 1	0–6 weeks	Immobilisation
Stage 2	4–6 weeks	Active assisted range of motion exercises, pendular exercises, scapular muscle activation exercises, isometric rotator cuff exercises. Most exercises performed in neutral position
Stage 3	6–12 weeks	Active range of motion exercises, mobility exercises, capsular stretches, progressive resisted exercises for the rotator cuff and scapular muscles using elastic resistance and/or dumbbells, aerobic conditioning exercises, neuromuscular training, isokinetic training.
Stage 4	3–6 months	Overhead training, plyometric training, sports-specific training (if applicable), return to activity.

ASD can be associated with secondary injuries such as avulsion of glenohumeral ligaments, labral damage, rotator cuff pathologies, axillary nerve injury and bony damage such as the Hill Sachs lesion.[7 8] Injury of concomitant structures may predispose an individual to recurrence of dislocation, chronic symptoms, reduced activity participation and decreased quality of life (QOL).[9] ASD and recurrence can contribute to shoulder muscle dysfunction and reduced proprioception.[10] Indeed, recurrence of ASD is a common complication, especially in young active males with rates as high as 64%.[11]

Typical principles of ASD rehabilitation include a focus on dynamic strength and control of the glenohumeral and scapulothoracic musculature, proprioceptive retraining and functional progression.[12] The deltoid and rotator cuff muscles form a force couple that keep the humeral head centred in the glenoid cavity, while an anterior–posterior force couple is formed by subscapularis anteriorly and the infraspinatus posteriorly.[13] Disruption of the deltoid-rotator cuff force couple can give rise to deltoid overactivity, resulting in increased superior translation of the humeral head.[14]

Exercise-based interventions (EBIs) are an integral component of post-ASD recovery either alone, or in combination with surgical interventions. ASD management requires a phasic, criteria-driven and graded exercise programme that restores strength, range of motion (ROM) and function of the glenohumeral joint.[15] The current literature reflects a range of different EBI, as summarised in table 1. There is a need to better understand the effects of EBI (ie, EBI in conjunction with surgery and EBI in the absence of surgery, hereafter: 'EBI alone' and 'multimodal EBI'[16] that uses additional strategies other than a home-exercise programme such as neuromuscular exercise and ultrasound-guided elastic resistance training) on recurrence and functional outcomes.[17] Neuromuscular exercise in this context includes strength, coordination, balance and proprioception under the guidance of an exercise-based professional; whereas the elastic resistance training uses a range of movements, while using ultrasound to optimise recruitment of appropriate musculature.[9] While several studies have investigated EBI as a component of ASD management,[9 18 19] to date no systematic review and meta-analysis has evaluated the effectiveness of EBI for ASD by comparing different types of EBI. This study aimed to review and synthesise the literature to compare the effectiveness of surgery in conjunction with EBI to EBI alone on recurrence, return to activity (RTA) and functional outcomes in adults who sustain an ASD in athletic and non-athletic settings.

METHODS

We carried out a systematic review and meta-analysis investigating EBI following ASD. The Preferred Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed for the conduct and reporting of this study.[20] Further, the PRISMA-S extension[21] was used to guide our search methodology. This review was prospectively registered with the International Prospective Register of Systematic Reviews (PROSPERO) (registration number CRD42021262494).

Literature search

We searched the following electronic databases: MEDLINE (PubMed), Web of Science (EBSCO), Scopus (EBSCO) and Google Scholar (Google) for suitable studies conducted from 1990 to May 2022, in English language only. This search was updated in March 2023. Controlled vocabulary (Medical Subject Headings (MeSH) in MEDLINE), for example, "anterior shoulder dislocat*" for "anterior shoulder dislocation", and "exercise therap*" for "exercise therapy", were used. The full search strategy can be accessed in online supplemental table S1. From the search, all identified citations were collated and uploaded into Mendeley Reference Manager V.1.19.4 (Elsevier Mendeleyd, London, UK).

Inclusion and exclusion criteria

The 'PICOS framework' (ie, population, intervention, comparison, outcomes, study type) was used for the inclusion and exclusion of studies.

Population

Adults who sustained an ASD in an athletic or occupational setting.

Intervention

Any EBI (ie, EBI alone or EBI in conjunction with surgery) for treating ASD, including strength, neuromuscular control/proprioception, plyometrics and mobility training.

Comparison

Standard treatment defined as usual practice either after surgery or as a stand-alone.

Outcomes

Primary outcomes: recurrence, RTA (ie, sport, work or regular activities of daily living).

Secondary outcomes:

Self-reported measures:

1. American Shoulder and Elbow Surgeons Scale (ASES).
2. Constant-Murley Score (CMS).
3. The Disabilities of the Arm, Shoulder and Hand questionnaire (DASH).
4. Rowe score.
5. Visual Analogue Scale (VAS).
6. Western Ontario Shoulder Index (WOSI).
7. Shoulder muscle strength.
8. Shoulder ROM.

Study type

We included randomised controlled trials (RCTs), quasi-RCTs or observational studies that only evaluated the efficacy of an EBI either postoperatively, or as stand-alone non-surgical management for ASD. We excluded case reports, secondary research and conference papers. For our meta-analyses, only studies that included both a control and an experimental (ie, surgery+EBI or multimodal EBI) group were synthesised.

Exclusion criteria

1. Non-human or cadaveric studies.
2. Studies involving non-ASD shoulder injuries such as recurrent shoulder dislocation, multidirectional instability, shoulder impingement syndromes, acromioclavicular or sternoclavicular injuries, and posterior shoulder dislocation;
3. Passive interventions or non-EBI such as immobilisation, closed reduction and passive pain modulating physiotherapeutic modalities such as electrotherapy.
4. Studies that did not describe or report any rehabilitation following an ASD.
5. Studies that focused on postoperative complications.
6. Studies that focused only on assessment of traumatic ASD only.

Study selection

Two authors (VC and TL) independently screened the title and abstracts of the studies identified from the search, and then independently screened full-texts of relevant studies. Following this, a reference list search was performed by CD to identify any additional relevant studies. Initially, any disagreements were discussed with a fourth author (RMJdZ) at both abstract and full-text stages, until consensus was reached.

Risk of bias assessment

Two independent reviewers (RMJdZ and VC) assessed the risk of bias and methodological quality of eligible articles using the previously validated Downs and Black checklist.[22] Twenty-seven items were rated as yes (=1) or no/unable to determine (=0), and one item (number 27 that assessed power calculation) was rated on a 3-point scale (yes=2, partial=1 and no=0).[23] Scores range from 0 to 28 including the adjustment question 27 to a binary (yes/no) response (ie, sufficient power with sample size or not). The higher the score, the better the methodological quality and hence lower risk of bias. The quality of studies was categorised as follows: excellent (26–28), good (20–25), fair (15–19) and poor (14).[24] Points were only awarded if a study clearly met the criteria. If there was disagreement between reviewers (RMJdZ and VC), a third assessor (TL) provided consensus.

Data extraction

Data were extracted by TL and CD using a standardised data extraction tool (JBI SUMARI, JBI Adelaide, SA, Australia) and Excel spreadsheets (Microsoft Excel V.2016, Microsoft, Redmond, Washington, USA). The extracted data included details of the population, study methods, interventions and outcomes relevant to the review objective. The authors of papers were contacted to request any missing or additional data, where required. If the authors did not respond within 2 weeks, they were contacted again to follow-up. If data were not obtained within 4 weeks the study, or the relevant section thereof, was not included in the review.

Statistical analyses

Means, SD and sample sizes were extracted for all continuous outcome measures; hedges' g effect sizes and the respective 95% CIs were calculated, with the magnitude of effect defined using standardised conventions, with small, moderate and large effect sizes aligning with 0.20, 0.50 and 0.80.[25] Data were analysed via a change score from premeasurement to postmeasurement using weighted mean differences and Hedges' g effect sizes in the random effects model (Knapp-Hartung SEs using the Sidik-Jonkman model, as the best model accounting for normality and sparse data bias.[26–28] For categorical data (recurrence and RTA), data were analysed using both standardised (risk ratio) and unstandardised models (log risk ratio). For alternative methods of data reporting, they were converted into a corresponding effect size (eg, SE of the mean was converted to SD using the following formula SE x the square root of the number of participants=SD). If data extraction of an included study was not possible, the study was excluded from quantitative analysis. If requested data were not provided, the outcome was excluded from quantitative analysis, but used to inform qualitative synthesis. If data could be obtained from figures or graphs, extrapolation of the mean and respective measure of variance was conducted using digitisation software (Get Data Graph Digitizer), and conversions applied to estimate the respective effect size and 95% CIs. Statistical heterogeneity was investigated for studies by calculating Cochrane's Q, where significant heterogeneity was indicated by $p\leq0.10$. The magnitude of statistically significant heterogeneity was determined using the I^2 statistic, where values of 25%, 25%–75% and 75% represent low, moderate and high levels of heterogeneity, respectively.[29] Where heterogeneity exceeded moderate (>50%), follow-up analyses were conducted to investigate the source of this heterogeneity, such as time since surgery, point of measurement (follow-up time). Specifically, a leave-one-out sensitivity analysis was conducted, where the overall effect from removing a single study was examined. All analyses were carried out in Stata V.17.0 MP (StataCorp).

For the primary outcomes (recurrence and RTA), the potential of non-reporting bias was evaluated by using the Outcome Reporting Bias in Trials (ORBIT) framework[30 31] to investigate potential missing results. The Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach was used to determine the certainty and strength of evidence carried out in accordance with set recommendations.[25] For example, observational studies were assigned a 'low' certainty of recommendation prior to then either being upgraded or downgraded from this point, based on the quality of the evidence.[32] Studies were upgraded for factors such as large effect sizes or dose–response relationships between the intervention (eg, surgical+EBI) and outcomes (ie, recurrence, RTA, self-report measures and functional outcomes). Studies were downgraded according to GRADE for non-reporting bias, indirect relationships with results (unexplained confounding) or inconsistencies between studies. From this process, qualitative ratings for the certainty of evidence and recommendations were listed as 'high', 'moderate', 'low' or 'very low', and were able to be interpreted according to the GRADE approach.[32]

Equity, diversity and inclusion statement

Our research team comprises female and male members, early-career and mid-career researchers, representation from diverse disciplines, and hailing from three countries. In our study, we specifically focused on individuals with traumatic ASD in both athletic and non-athletic contexts, ensuring representation of both males and females. It is important to note that the majority of studies conducted in this field are carried out in higher resource countries, often published by more developed nations. Unfortunately, there is a notable absence of publications from lower resourced countries, which highlights a disparity in research findings between settings with varying resource levels. We acknowledge that the findings derived from our study may

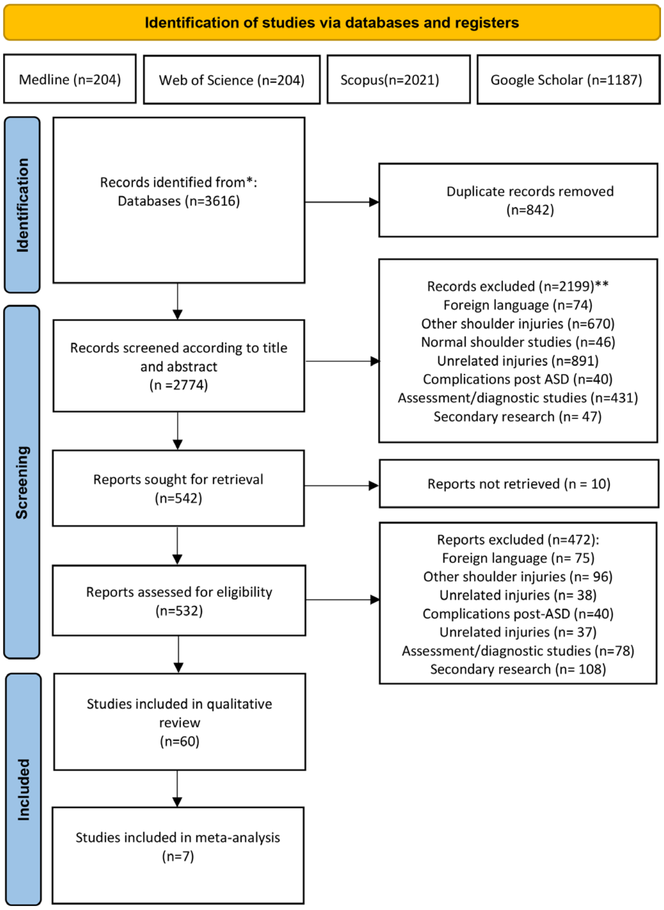

Figure 1 PRISMA flow diagram[20] delineating the number of studies included and excluded through each stage of screening. *Indicates the four outlined databases at the top of this figure. **Indicates total number of records excluded at title/abstract stage. ASD, anterior shoulder dislocation; PRISMA, Preferred Items for Systematic Reviews and Meta-Analyses.

have limited generalisability due to the specific to settings with fewer resources, presenting distinct challenges and requiring tailored approaches. There is a need for further investigations conducted in diverse settings to help bridge the existing knowledge gaps and promote equitable healthcare practices globally. Despite these constraints, our study provides valuable insights that can significantly contribute to future research, interventions and policy-making within the identified context.

RESULTS

Across four databases, 3616 studies were identified, and 842 duplicates were removed. Figure 1 illustrates the identification of studies and each of the stages for the review process according to the PRISMA flow diagram.[20] From a total of 2285 titles and abstracts screened, and 576 full-text articles assessed, 60 studies (n=3598) were included for qualitative synthesis and 7 (n=345) studies were included in the meta-analysis. The mean age of participants in the included studies was 26.71±9.19 and 56% of those included were male.

Study characteristics

The characteristics of the studies, participants and interventions are summarised in online supplemental table S2. Of the included studies, 46 focused on EBI combined with surgical intervention, and 14 focused on EBI alone. Data from nine studies were pooled for meta-analysis, with a total of 411 participants (n=228 EBI in conjunction with surgery; n=168 EBI alone). Some of the common components of EBI were: mobility exercises such as active ROM, active assisted ROM, capsular stretching exercises and strength training, including: resisted rotator cuff and scapular stabilisation exercises (60 studies). Other interventions were sports-specific training (seven studies), overhead training (three studies), aerobic conditioning (four studies), isokinetic exercises (one study), Bodyblade resisted vibration training (one study), hydrotherapy (one study), plyometric training (three studies) and neuromuscular training (three studies). The median length of follow-up across the studies was 0.9 years and ranged from 3 weeks to 7 years. The included studies used a range of both self-reported and objective measures to assess physical function. In 36 out of 60 studies, the number of male participants was higher than female participants. Overall, there were 2150 male participants and 463 female participants, across the 60 studies.

Quality of studies

Of the 60 studies included in the systematic review, 29 were fair quality (48.3%), 15 studies were good quality (25%) and 16 studies were poor quality (26.7%). The risk of bias (internal validity—confounding bias) within the included studies was low or unclear as a majority of the studies were observational in design (34/60). The individual scoring of each included study can be found in online supplemental table S2. The ‘reporting’ of the included papers scored high, with the commonly unreported aspect being failure to report adverse events following the intervention, and the characteristics of the participants lost due to adverse events. While these studies may not have had participants who experienced adverse events, reporting this in the paper would still have been beneficial. External validity was generally high due to the inpatient, outpatient or home settings incorporated in the included studies. However, all studies restricted normal daily free-living activities until 4–6 months following ASD to enhance internal validity. The included studies took a varied approach to the data collection and analysis of their outcome measures, influencing internal validity. One study used a blinded interpretation framework to reduce the bias of interpretation,[9] thereby increasing its internal validity. Three studies blinded the investigator measuring the outcomes,[33–35] while many studies (33/60) did not. The level of agreement (kappa) for the methodological quality assessment was 0.90 (weighted kappa: 0.66).

The GRADE certainty of evidence was low for recurrence and RTA (see online supplemental table S3).

Meta-analysis

For each of the primary and secondary outcome measures, the results of the meta-analysis are presented below.

Non-recurrence

The meta-analysis for non-recurrence was based on pooled data from four studies with a total of 216 participants. Of the total, 94 underwent EBI alone while the remaining 122 underwent EBI in conjunction with arthroscopic surgery. There was substantial heterogeneity in the true outcomes of recurrence (I^2=51.17%). Non-recurrence was significantly better following EBI in conjunction with surgery. Individuals who underwent EBI in conjunction with surgery were 2.03 times more likely to have treatment success (ie, not sustain a recurrent ASD) than

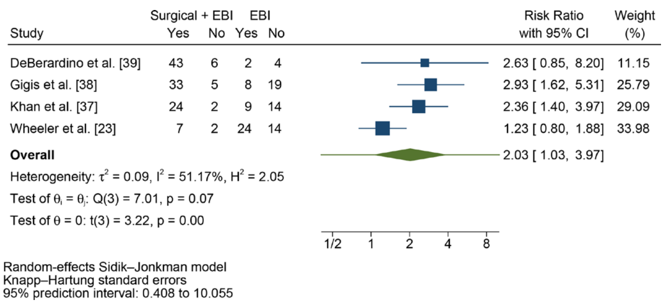

Figure 2 Forest plot from the meta-analysis showing head-to-head comparison between non-recurrence outcomes following EBI in conjunction with surgery and EBI alone. Event, successful treatment; yes, successful treatment with no episode of ASD recurrence; no, unsuccessful treatment marked by episode of ASD recurrence. ASD, anterior shoulder dislocation; EBI, exercise-based intervention.

individuals who underwent EBI alone (RR 2.03, 95% CI 1.03 to 3.97) (figure 2) (online supplemental figure 1).

Return to activity

The meta-analysis for RTA included three studies, with a total of 143 participants. Of the total, 39 participants underwent EBI alone and the remaining 104 underwent EBI in conjunction with surgery. There was low heterogeneity in the true outcomes of RTA (I^2=12.68%). RTA was significantly better following EBI in conjunction with surgery. Individuals who underwent EBI in conjunction with surgery appeared 1.81 times more likely to RTA following ASD than individuals who underwent EBI alone, although results ranged from no improvement in RTA to over three times more likely with surgery (RR 1.81, 95% CI 0.96 to 3.43) (figure 3) (online supplemental figure 2).

Self report measures

The meta-analysis included the following comparisons:

Rowe score

One study with a total of 65 participants. Of the total, 38 participants underwent EBI in conjunction with surgery and 27 underwent EBI alone (figure 4). The outcomes were in favour of EBI in conjunction with surgery when compared with EBI alone but were not statistically significant (Hedges' g 0.33, 95% CI −0.16 to 0.82, p=0.19).

Constant-Murley Score

One study with a total of 30 participants. Of the total, 15 participants underwent EBI in conjunction with surgery and 15 underwent EBI alone (figure 4) (online supplemental figure 3). The outcomes were in favour of EBI in conjunction with surgery when compared with EBI alone and were statistically significant (Hedges' g 1.60, 95% CI 0.79 to 2.40, p<0.001).

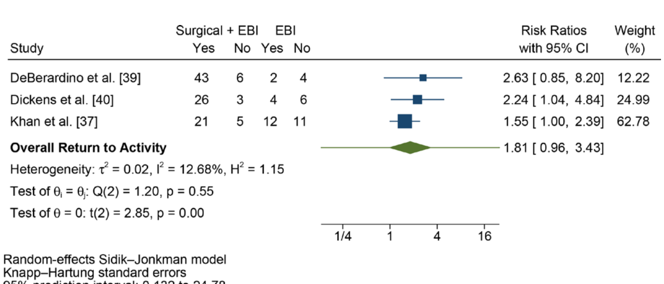

Figure 3 Forest plot from the meta-analysis showing head-to-head comparison between RTA outcomes following EBI in conjunction with surgery and EBI alone. EBI, exercise-based intervention; RTA, return to activity.

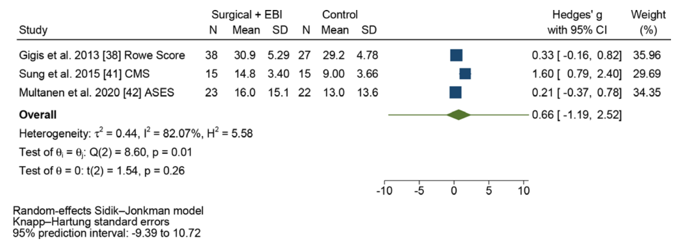

Figure 4 Forest plot from the meta-analysis showing comparison between self-report outcomes (ASES, CMS and Rowe Scores) following EBI in conjunction with surgery and EBI alone. ASES, American Shoulder and Elbow Surgeons Scale; CMS, Constant-Murley Score; EBI, exercise-based intervention.

American Shoulder and Elbow Surgeons Scale

One study with a total of 45 participants. Of the total, 23 participants underwent EBI in conjunction with surgery while 22 underwent EBI alone (figure 4). The outcomes were in favour of EBI in conjunction with surgery when compared with EBI alone but were not statistically significant (standard mean difference (SMD) 0.21, 95% CI −0.37 to 0.78, p=0.48).

Overall, for these self-report measures the outcomes were in favour of EBI in conjunction with surgery when compared with EBI alone, but was not statistically significant (Hedge's g 0.66, 95% CI −1.19 to 2.52, p=0.26). Heterogeneity was I^2=82.07% (considerable heterogeneity) for this model (Sidik-Jonkman). The estimates and prediction intervals are shown in figure 4.

We conducted a subgroup analysis for the CMS per the function, pain, ROM, strength and overall composite score components. The scores for each component were compared between the EBI in conjunction with surgery group, and EBI alone group. Heterogeneity was I^2=48.35% (considerable heterogeneity) for this model (Sidik-Jonkman). The CMS scores were not normally distributed as indicated by the skewness 1.81 for the mean change score for surgical and EBI and 0.97 for the mean change-score for EBI alone. The subgroup analysis demonstrated the following CMS component specific results:

1. Pain—outcomes in favour of EBI in conjunction with surgery when compared with EBI alone (Hedge's g 0.95, 95% CI 0.21 to 1.69).
2. Function—outcomes in favour of EBI in conjunction with surgery when compared with EBI alone (Hedge's g 1.43, 95% CI 0.65 to 2.22).
3. ROM—outcomes in favour of EBI in conjunction with surgery when compared with EBI alone (Hedge's g 1.14, 95% CI 0.39 to 1.89).
4. Strength—outcomes in favour of EBI alone when compared with EBI in conjunction with surgery (Hedge's g 2.32, 95% CI 1.41 to 3.24).
5. Total score—outcomes in favour of EBI in conjunction with surgery when compared with EBI alone (Hedge's g 1.60, 95% CI 0.79 to 2.40).

Overall, for this one study, there were improved CMS scores for each subscale and total score for surgical and EBI, when compared with EBI alone (Hedge's g 1.45, 95% CI 0.82 to 2.09, p<0.001). The estimates and prediction intervals are shown in figure 5 (online supplemental figure 4).

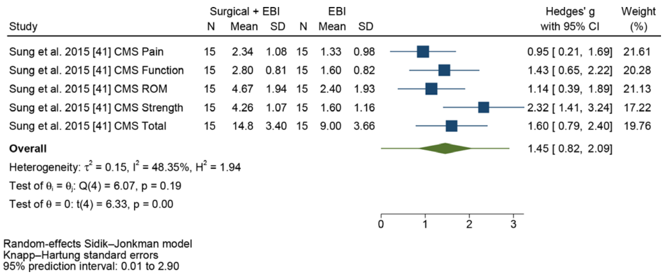

Figure 5 Forest plot from the meta-analysis showing head-to-head comparison for CMS-specific outcomes following EBI in conjunction with surgery and EBI alone. CMS,Constant-Murley Score; EBI, exercise-based intervention.

Physical function measures: strength

The meta-analysis for strength outcomes was based on one study with a total of 45 participants.[36] Of the 55 participants, 23 underwent EBI in conjunction with surgery and 22 underwent EBI alone. All participants followed the same rehabilitation protocol for the first 2 months, which included immobilisation in a suspension sling for 3 weeks, and light household activities. The experimental intervention was started 2 months after the surgery. All follow-up assessments (including control group and exercise group participants) were performed individually. The first follow-up was completed 2 weeks after starting the experimental intervention (ie, 10 weeks postsurgery). The second follow-up was 6 weeks after starting the experimental intervention, with subsequent follow-ups at 4 and 6 months after starting the experimental intervention.

Outcomes for each group of muscles tested were compared, as follows:

1. Grip strength—outcomes in favour of EBI alone, but not statistically significant (Hedge's g −0.26, 95% CI −0.83 to 0.32, p=0.38);
2. External rotation strength—outcomes in favour of EBI alone, however, but not statistically significant (Hedge's g 0, 95% CI −0.57 to 0.57, p=1.00).
3. Internal rotation strength—outcomes in favour of EBI alone (Hedge's g −1.05, 95% CI −1.67 to −0.44).

Overall, strength outcomes were not statistically significant (Hedge's g −0.43, 95% CI −1.78 to 0.93, p=0.31). The heterogeneity was moderate with I^2=69.48% (figure 6) (online supplemental figure 5).

Physical function: ROM

Active AROM

Of the total 75 participants, 38 underwent EBI in conjunction with surgery and 37 underwent EBI alone (figure 7) (online supplemental figure 6).

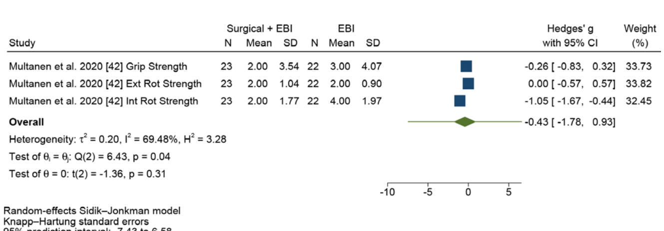

Figure 6 Forest plot from the meta-analysis showing head-to-head comparisons between strength outcomes following EBI in conjunction with surgery and EBI alone. EBI, exercise-based intervention.

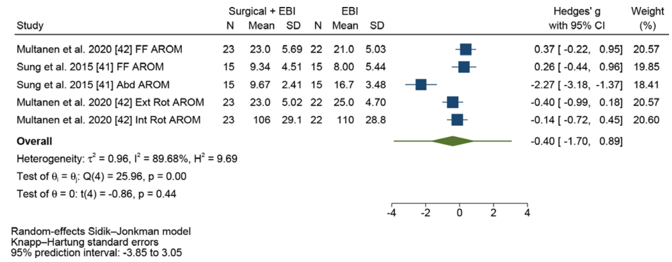

Figure 7 Forest plot from the meta-analysis showing head-to-head comparison between AROM outcomes following EBI in conjunction with surgery and EBI alone. AROM, active range of motion; EBI, exercise-based intervention.

The meta-analysis for Forward flexion AROM was based on two studies with a total of 75 participants. Of the total, 38 participants underwent EBI in conjunction with surgery and 37 underwent EBI alone. The outcomes were in favour of EBI in conjunction with surgery, but were not statistically significant (Hedge's g 0.32, 95% CI −0.12 to 0.77, p=0.16). Outcomes for the movements tested for AROM were compared, as follows:

1. Abduction AROM—The meta-analysis was based on one study with a total of 30 participants. Of the total, 15 participants underwent EBI in conjunction with surgery and 15 underwent EBI alone. The outcomes were in favour of EBI alone, but not significant (Hedge's g −2.27, 95% CI −3.18 to −1.37).
2. External rotation AROM: The meta-analysis was based on one study with a total of 45 participants. Of the total, 23 participants underwent EBI in conjunction with surgery and 22 underwent EBI alone. The outcomes were in favour of EBI alone but not statistically significant (SMD −0.40, 95% CI −0.99 to 0.18, p=0.17).
3. Internal rotation AROM: The meta-analysis was based on one study with a total of 45 participants. The outcomes were in favour of EBI alone but not statistically significant (Hedge's g −0.14, 95% CI −0.71 to 0.44, p=0.64).

Overall, AROM outcomes were in favour of EBI alone, but were not statistically significant (Hedge's g −0.40, 95% CI −1.70 to 0.89, p=0.44). The heterogeneity was high with I^2=89.68% (figure 7) (online supplemental figure 6).

Passive range of motion

Overall, the passive range of motion (PROM) outcomes were in favour of EBI in conjunction with surgery when compared with EBI alone. However, the outcomes were not statistically significant (Hedge's g 0.07, 95% CI −0.74 to 0.89, p=0.86). Outcomes for the movements tested for PROM were compared, as follows:

1. Abduction PROM—The meta-analysis was based on one study with a total of 30 participants. Of the total, 15 participants underwent EBI in conjunction with surgery and 15 underwent EBI alone. The outcomes were in favour of EBI alone, and were statistically significant (Hedge's g −1.13, 95% CI −1.89 to −0.38, p<0.001).
2. External rotation PROM—The meta-analysis was based on two studies with a total of 75 participants. Of the total, 38 participants underwent EBI in conjunction with surgery and 37 underwent EBI alone. The outcomes were in favour of EBI in conjunction with surgery, and were statistically significant (Hedge's g 0.89, 95% CI 0.29 to 1.49, p<0.001).
3. Forward flexion PROM—The meta-analysis was based on one study with a total of 30 participants. Of the total, 15

participants underwent EBI in conjunction with surgery and 15 underwent EBI alone. The outcomes were in favour of EBI in conjunction with surgery, but were not statistically significant (Hedge's g 0.19, 95% CI −0.51 to 0.89, p=0.59).
4. Internal rotation PROM: The meta-analysis was based on two studies with a total of 75 participants. Of the total, 38 participants underwent EBI in conjunction with surgery and 37 underwent EBI alone. The outcomes were in favour of EBI in conjunction with surgery, but were not statistically significant (Hedge's g 0.27, 95% CI −0.31 to 0.84, p=0.37).

The heterogeneity was high with I^2=84% (figure 8) (online supplemental figure 7).

Qualitative synthesis

Primary outcomes:

Recurrence

Eleven included studies evaluated recurrence following ASD.[37–47] In one study,[37] the mean (±SD) age of participants was 23.49±7.3 years, with a recurrence rate of 18.2% following an arthroscopic repair and EBI. Another study[43] included 20 naval officers who underwent a 4-month EBI, of whom five sustained a recurrence (three of these occurring within 6 months of the ASD). This suggests that clearance of participants to unrestricted sporting or occupational activities must be cautiously recommended during the first 6 months following an initial episode of ASD. Another study[44] followed 30 athletes who sustained an ASD. All participants underwent the same course of physical therapy that included strength and mobility training.

On average, there were 1.4 in-season recurrences per season, per athlete. The chances of recurrence were higher in athletes who returned to sport within the same season, an important consideration for return to play decisions. A case series of 42 consecutive patients[38]—who, on average, participated in sports for 2 hours a day, 3 days a week before they sustained an anterior-inferior shoulder dislocation—reported an overall recurrence rate of 22.5%, mostly occurring within the first year following arthroscopic capsulo-labral reconstruction. All of these except one were contact or overheard athletes. Overhead athletes were more at risk of recurrence compared with other included participants. A negative relationship between the University of California at Los Angeles Shoulder Score (UCLA) and rate of recurrence was observed: that is, lower functional rating on UCLA was accompanied by higher rates of recurrence (33.1% in the low UCLA group vs 29.1% in the high UCLA group). Overall, recurrence was higher within a year of the initial episode in young active males, and in

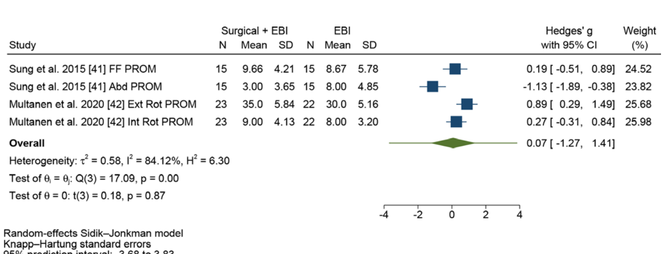

Figure 8 Forest plot from the meta-analysis showing head-to-head comparison between PROM outcomes following EBI in conjunction with surgery and EBI alone. EBI, exercise-based intervention; PROM, passive range of motion.

individuals who returned to their preinjury level of activity within 6 months.

Return to activity

Of the included studies, 12 looked at RTA following ASD.[9 39 41–46 48–51] The studies used a range of EBIs including postsurgical EBI,[39 41 42 45 46 48–51] multimodal EBI[9] and EBI alone.[43 44 48 50] The majority of studies among non-athletes reported RTA at 3–4 months following ASD, whereas one study of athletes[51] reported an average RTA of 8.4 months following arthroscopic stabilisation and postoperative EBI. Most of the included studies report successful RTA (as high as 80%–90%) indicating that EBI can help to facilitate successful RTA. As outlined above, this finding is supported mostly by studies (n=9) that included surgery and postoperative EBI.

Secondary outcomes: self-report measures

Rowe score

The Rowe score (0–100; where higher scores reflect greater function) was reported in seven studies,[37–40 52–54] of which four[37 39 52 54] reported follow-up scores. Studies reported Rowe scores after 13 years[37] (median±SD= 90.0±20.5), 6 weeks[54] (mean±SD=81.8±24.9 and 84.8±23.3 for dominant and non-dominant), and 2 years (mean=96.5). Archetti Netto *et al*[52] compared outcomes of open and arthroscopic Bankart repairs (each with postsurgical EBI), and reported the following outcomes: 79% excellent, 14% good and 7% fair Rowe scores (descriptive data not provided). Three studies reported changes from surgery plus EBI from baseline to follow-up including statistically significant improvements (all p≤0.001) in mean scores from preoperative (range: 24–64) to postoperative (range: 80–90).[38 40 53] Interventions for each included: arthroscopic Bankart repair plus EBI,[38] open reconstruction plus EBI[40] and open Bankart repair plus multimodal EBI.[53]

Western Ontario, Shoulder Instability Index

The WOSI was used as a QOL outcome measure in six studies with 446 participants.[5 9 31 42 55] The WOSI is a 21-item scale assessing physical symptoms, sport/recreation/work function, lifestyle function and emotional function (higher score indicates worse QOL). Participants in one study[55] demonstrated an improvement in their WOSI scores (mean±SD), 4.5±2.5 years following shoulder reconstruction. They underwent a 4-week postoperative rehabilitation programme (ROM exercises, dynamic strengthening) and returned to activity at 6 months, with a 15%±15% improvement in their WOSI scores at follow-up. Participants in another study[9] underwent two different forms of EBI (neuromuscular rehabilitation, or home-based exercises). This study found no statistically significant difference in total or subdomain WOSI scores. Another study among athletes (n=62)[56] investigated enhanced-EBI (ie, functional rehabilitation programme comprising supervised ROM, strengthening and plyometric exercises) following arthroscopic Bankart repair. Mean WOSI scores preoperatively were 1578.0±60.9 and 178.9±32.3 postoperatively at 2 years (Δ 1399.1±63.2, p<0.001).

One study[57] investigated outcomes cross-sectionally following three to 6 weeks of enhanced-EBI only for both ASD and recurrent-ASD (most-recent occurrence). Those who had experienced an ASD (n=34) had a mean±SD WOSI score of 1064±373.2, compared with 1048.3±371.5 among individuals with recurrent-ASD (n=22). Though no comparison was drawn between a control, or EBI in conjunction with surgery, this study demonstrated that there was no statistically significant between group difference. A second study[58] investigated the effectiveness of three EBI only protocols: traditional (ie, resistance band-based exercise), Bodyblade (ie, resisted vibration exercise), and a mixed programme of both—over an 8-week period. All three groups improved significantly at 8 weeks follow-up, with no significant difference between them. At the 8-week follow-up a 59.4% improvement in WOSI score was observed in the traditional EBI group, a 56.5% improvement in the Bodyblade group, and 43.3% improvement in the mixed group. A third study,[42] compared two types of surgical management for ASD (traditional vs immediate arthroscopic stabilisation). One group underwent a 3-week immobilisation period followed by physiotherapy, while another group underwent a 4-month rehabilitation programme. All participants demonstrated a significant improvement in WOSI scores at the 24-month follow-up with the immediate surgical group showing significantly better results (287.01±290.19) than the traditional group (633.93±547.25) (p=0.03). In another study,[5] 252 participants underwent sling immobilisation and a 12-week rehabilitation programme. There was no significant improvement in WOSI score at the 1-year and 2-year follow-up assessments. Overall, the included studies reported on a range of ASD management approaches, and had varying lengths of follow-up and rehabilitation programmes. WOSI scores improved in participants who underwent a well-structured EBI, in conjunction with surgery.

Constant Murley Score

The Constant Murley Score (0–100; where higher scores reflect greater function) was reported in two studies.[37 57] This study reports on a 13-year follow-up of patients who underwent arthroscopic Bankart repair with postoperative EBI. Except for a standardised postoperative ROM protocol, a physiotherapist determined an appropriate rehabilitation programme. While no preintervention data are reported, the Constant Murley Score (mean±SD) of 104 participants was 94.0±9.1 at 13-year follow-up, similar to those not reporting recurrence. The Constant Murley Score was also used in the aforementioned study[57] cross-sectionally comparing 3–6 weeks of enhanced-EBI for ASD (initial occurrence) and recurrent-ASD (most recent occurrence), respectively. Scores were 70.4±19.4 for the recurrent-ASD group, and 64.4±19.1 for the ASD group. Again, no significant between group difference was observed.

American Shoulder and Elbow Surgeon's shoulder score

The ASES was used to measure postoperative QOL in six studies with a total of 336 participants.[36 37 53 55 59 60] With 100 maximum points, this scale weighs 50% of its questions to assess pain and 50% to assess function. Participants from two studies with a 1-year follow-up reported an improvement of 16 points (95% CI 10 to 23)[36]; and (64±19.7 to 92.1±3.5 at follow-up p<0.001), following arthroscopic Bankart repair with multimodal EBI.[53] Similarly, 83 participants from a study,[60] demonstrated an improvement in ASES scores at 33 months following arthroscopic Bankart repair plus multimodal EBI 75.4±17.6 to 94.9±9.6). Another study investigating multimodal-EBI following arthroscopic Bankart repair[56] reported significant ASES score improvements. Preoperatively ASES scores were 45.5±3.4, and 2 years postoperatively were 89.3±3.2 (Δ 43.8±4.0, p<0.001). Participants in one study[55] reported their satisfaction level (with respect to pain and function) as extremely satisfied following capsule repair (92±12, range: 60–100), with a mean follow-up period of 4.5 years. Another study[37] reported ASES scores 93±17.6, but with a longer follow-up period of 13 years following arthroscopic Bankart repair plus EBI. Further, participants who experienced a recurrent episode of shoulder instability during the follow-up period reported lower ASES scores (87.9±15.9) when compared with participants who did not have a recurrent episode of shoulder instability (93.2±9.1). Overall, ASES outcomes were observed to improve through surgical intervention in combination with EBI. All the studies reported an improvement that exceeded the minimal clinically important difference range of 6.4–17 points.[61]

Disabilities of the Arm, Shoulder and Hand questionnaire

The DASH outcome measure (0–100; 0=no disability; 100=severe disability) was reported in two studies.[52 62] Outcomes were reported at the following time points (mean±SD): preoperatively (14±14.6), 3 months (11.8±9.2), 4.5 months (5.7±4.4), 6 months (7.5±9.7), 9 months (4.1±4.7), 12 months (3.5±4.2) and 24 months (2.1±3.3). Netto *et al*[52] compared postoperative outcomes between arthroscopic and open Bankart repair procedures (n=50), both with postoperative EBI. Final follow-up was completed at mean time point of 37.5 months on a total of 42 study participants. Mean±SD were reported for both open (4.22±5.8) and arthroscopic (2.65±7.3) cohorts, with a significant difference between groups (p=0.031).

Pain intensity

Use of a VAS (VAS; 0=no pain; 10=maximal pain) for pain intensity was reported in four studies.[37 53 54 63] Hwan and So[63] reported improvements in pain intensity of 8.0 at baseline (initial, postinjury) to 2.0 at 5 months following rehabilitation with EBI alone. Additionally, Rhee and Lim[53] reported an improvement in pain intensity from 2.8 at baseline (preoperative) to 1.30 at 1 year following open Bankart repair. Two studies only presented data for 13-year[37] and 6-week[54] follow-up, without including any baseline data. One study used the numerical pain rating scale.[57] This previously detailed cross-sectional study compared ASD (initial occurrence) with recurrent-ASD (most recent-occurrence) following 3–6 weeks of multimodal-EBI only. No significant difference was observed between groups.

Shoulder Rating Questionnaire

The Shoulder Rating Questionnaire (SRQ),[64] a joint-specific questionnaire comprising five domains (VAS of overall function, pain, activities of daily living, recreational life and work), was reported in one study only.[65] For that study,[65] data were reported at baseline and at 9 months follow-up (lower scores reflected better function). Scores for the SRQ were significantly different between conditions at baseline (t=8.77, p<0.001) and the two time points (t=3.59, p<0.001). Despite this, when using a cut-off score of 11% change (indicating those who reported being 'much better'), there was a sensitivity value of 55% and specificity of 86% (AUC 0.68 via ROC curve). This indicates that the SRQ may be effective at excluding those with worse function but less effective at identifying those classified as 'much better'.

Lysholm score

One study included functional assessment of the shoulder via the Lysholm Score.[66] This scoring system[67] includes pain during activity, after activity and at rest using the VAS (0=no pain; 10=maximal pain). Assessments were undertaken in this study at 1-month, 6-month and 12-month follow-up with no statistically significant differences observed between arthroscopic and non-surgical treatment groups. However, the proportion of scores in the 'excellent' group (94–100 points) increased from 1-month to 6-month follow-up in both the arthroscopic (7%–53%) and non-surgical (7%–40%) treatment groups. There appeared to be a decrease in Lysholm Score from 6 months to 12 months.

University of California at Los Angeles Shoulder Score

Archetti Netto *et al*[52] report on the UCLA score (0–35; excellent=30–35, good=28–33, fair=21–27, poor=0–20) for 42 participants at a mean time point of 37.5 months. Results were categorised as good/excellent and fair/poor. Of the participants who underwent an open procedure, 23 (92.0%) reported a rating of either good or excellent, while 2 participants (8.0%) reported ratings of either fair or poor. Of the participants who underwent an arthroscopic procedure, 16 (94.1%) reported ratings of either good or excellent, and 1 participant (5.9%) fair or poor.

Oxford Instability Shoulder Score

Two studies reported on the Oxford Instability Shoulder Score (OISS) (12=best function, 60=worst function). Moser *et al*[65] assessed the outcomes for patients who participated in EBI for shoulder instability. Scores were reported at baseline and at 9 months. The OISS scores were reported as a percentage (mean±SD) and 95% CI's at different time points: baseline=45±20, 41–49; 9 months=21±19, 16–26; differential=−22±18, 17–26. Jakobsen *et al*[41] compared exercise-based rehabilitation with open Bankart repair in 76 patients following diagnosis via arthroscopy. The OISS was determined at 10 years following intervention. A total of 37 patients underwent surgical repair and 39 were managed non-surgically. Results were categorised as 'excellent' for 19 (53%) participants, and 'good' for 6 (17%) participants. In the non-surgically managed group, 24 (62%) participants experienced recurrence. The majority of these participants (n=19, 80%) underwent subsequent open or arthroscopic repair, with 63% reporting a 'good' or 'excellent' outcome according to the OISS. Overall, 29 (38.1%) of the participants managed non-surgically reported experiencing both pain and recurrence, yielding an OISS rating of 'unsatisfactory'. In the context of self-reported shoulder instability, EBI in conjunction with stabilising surgery, led to improved results.

Secondary outcomes: physical function

Strength

Strength measures were reported in seven studies in which rotator cuff strength was assessed using isokinetic dynamometers at varied angular velocities. A study of 79 patients[62] evaluated the weight-standardised peak torque (PT/W as %) at different time points (from 1.5 to 24 months postsurgery). Strength returned to presurgical values and was equal with the uninjured side at 6 months for external rotation (ER) and 4.5 months for internal rotation (IR). Another study[68] assessed rotator cuff strength at 12 weeks following the operation across three different velocities (90°/s, 210°/s and 300°/s). Unilateral external rotator and internal rotator ratio was regained in 9/20 at the slower velocity (90°), 5/20 at 210° and 4/20 at 300°, representing an anterior to posterior force couple at 60%–66% capacity. Lee *et al*[69] also found that neuromuscular factors (including strength, endurance and control) were suboptimal following arthroscopic Bankart repair, compared with those without ASD (IR strength: 670±1 vs 718±2 Joules, p=0.002, ER strength: 422±6 J vs 501±2 J, p=0.044). Following a 4-week upper-body wobble-board training programme (10 min duration, 5–6 days per week), Naughton *et al*[70] found that perceived stability and strength of the affected shoulder significantly improved (torque=10.95, p<0.001 and torque=6.17, p<0.001, respectively). Collectively, these findings indicate improvements in rotator cuff strength following both surgical and non-surgical interventions, and highlight the importance of the anterior to posterior force couple in post-ASD rehabilitation.

Range of motion

Glenohumeral ROM measures were reported in eleven studies[18 39 42 47 52 53 55 63 66 68 71] including ER, IR, flexion and abduction movements. Three studies assessed rotation ROM with the arm at 90° of abduction,[47 55 68] two measured it with arm in neutral[39 63] and one study measured elevation and ER ROM in the scapular plane.[52] All studies measured ROM in supine with one exception[42] where ROM was measured in sitting. Predominantly, ROM returned to presurgical values at follow-up. However, one study[68] found ROM deficits in 70% of the participants at 12 weeks postoperatively; while ER ROM deficits (mean loss: 11°, range: 5°–20°) at 6 weeks following an open Bankart repair were observed elsewhere.[39] Another study[42] noted a trend of ER ROM deficits following arthroscopic stabilisation. In contrast, Gaballah *et al* reported 90% improvement in ROM outcomes after a 6-week rehabilitation protocol. This study used a non-surgical approach to manage ASD, indicating that the mode of management (ie, surgical vs non-surgical) influences objectively measured ROM (particularly ER) outcomes.

DISCUSSION

This review aimed to investigate the effectiveness of EBI in the management of ASD by comparing the outcomes surgery with postoperative EBI versus EBI alone. Recurrence rates were lower, and there was more successful RTA following surgery with postoperative EBI. Improvements in self-reported outcomes were found for the ASES, CMS and Rowe score following surgery with postoperative EBI, compared with EBI alone. Considering that these outcomes include activities of daily living, behaviour, functional mobility, general health, life participation, mental health, pain and QOL—these improvements have clinical implications. There is a trend towards better shoulder strength and AROM outcomes following EBI alone, however, this was not statistically significant. Also, PROM outcomes were better following surgery with postoperative EBI but were not statistically significant. For some outcomes (CMS, VAS, WOSI, abduction AROM and forward flexion AROM) we compared multimodal EBI with standard EBI and found that these outcomes were better with multimodal EBI. Multimodal EBI included additional approaches such as neuromuscular exercise and therapeutic ultrasound with elastic resistance training.

Recurrence

The lower recurrence rates following EBI in conjunction with surgery align with normal ranges reported in previous literature.[72–74] The recurrence was especially high in young active males, competing in collision sports, overhead sports or involved in overhead occupations. This is an interesting insight given 2009 of the 3848 (52.2%) of the total participants included across 56 studies were males, a finding also consistent with previous studies.[4 75 76] Further, another systematic review which focused on young active males concluded that early surgical stabilisation has the advantage of preventing recurrence of ASD.[77] Our findings support the notion that surgery in conjunction with EBI reduce the risk of complications and improve functional recovery. However, several factors determine the prognosis following ASD including age, activity level and sport participation.[78] Our findings highlight that surgical management of ASD with arthroscopic or open Bankart repair can help to reduce the rate of recurrence. However, the time required for recovery can impact readiness for athletic and/or occupational participation.[79] Conversely, the risks of not considering surgery and subsequent EBI include high recurrence rates,[80] bone loss and subsequent decline in QOL.[80] It is therefore imperative that clinicians present their clients with evidence-based information on risks and benefits of non-surgical and surgical intervention to facilitate the decision-making process.[81] Relevant factors include: the natural history of shoulder instability, clinical and imaging findings, sport-specific and activity-specific demands, the duration of treatment and the individual's motivation.[19] Age is another key factor as younger adolescents aged <14 years are at a high risk of recurrence; and primary surgical treatment has been demonstrably effective in young individuals older than 14 years.[82 83] Furthermore, the nature of functional demands, as seen in young individuals who participate in throwing or overhead sports, can increase risk of recurrence.[84]

Return to activity

Previous studies on patient expectations for treatment of shoulder instability indicate that RTA is a primary concern, with one study showing that 95% of participants wanted to return to a preinjury level of activity.[79] The present investigation found that EBI in conjunction with surgery appeared 1.81 times more likely to facilitate successful RTA compared with EBI alone. There is no consensus as to the appropriate time for RTA[83] though it is agreed that participants should have minimal pain, symmetrical shoulder strength and sport-specific ROM capability to successfully RTA.[85–87] Further, there is discussion of a 90%–100% strength regain being appropriate prior to returning to sport.[80 86–88] Therefore, the decision to permit RTA following any form of management (EBI alone or EBI in conjunction with surgery) must consider progression at each stage of the intended RTA process. The findings of this study suggest that EBIs in conjunction with surgery improve the likelihood of successful RTA. However, the decision to permit this must be criteria-driven, and informed by detailed clinical examination.

Self-report measures

This review meta-analysed self-report measures as secondary outcomes in the management of ASD, comprising ASES, CMS and Rowe scores. From this analysis, improvements were only observed for the CMS score following surgery with postoperative EBI. This measure comprehensively assesses shoulder function and has the ability to detect change following injury.[86 89] This self-report measure has been previously used in a range of settings including on the sporting field and in orthopaedic practice.[89] This finding is not without limitation as it is based on a single study, and the CMS is not a specific scale to measure functional outcomes following ASD.[90] The included studies reported on a range of self-report measures, including: the Rowe score, the WOSI and the Constant Murley score, ASES, UCLA, Lysholm score, Tampa scale of kinesiophobia, pain intensity. The studies had varying lengths of follow-up and rehabilitation programmes, but overall, results suggest that EBI, including multimodal programmes, in conjunction with surgery can improve self-reported function as measured by the Rowe score and WOSI, while the Constant Murley Score appears to remain stable over time. However, more studies are needed to provide a more definitive conclusion on the effectiveness of different management approaches for anterior shoulder instability.

Physical function

Strength

We investigated comparisons between EBI alone and EBI in conjunction with surgery to determine their effectiveness on strength outcomes. The improvements in shoulder IR strength were significant, which could be explained by the specific characteristics of the muscle strengthening programmes. A focus on shoulder IR strength is commonplace in post-ASD rehabilitation programmes given the role that the related musculature (ie, subscapularis and pectoralis muscles) play in anterior stability of the shoulder.[91] As well as strength deficits, surgical interventions are often associated with postoperative pain which may also contribute to weakness due to reflex neuromuscular inhibition. Furthermore, immobilisation following surgery contributes to weakness associated with disuse atrophy.[87 92] This is not surprising as strength deficits following surgery often do not recover until at least 7–8 months.[80]

Range of motion

We included comparisons between EBI in conjunction with surgery and EBI alone for the following movements: shoulder flexion, abduction, ER, and IR AROM and PROM. Significant improvements in abduction PROM following EBI alone were demonstrated. The included study had a rehabilitation protocol that focused on mobility, which demonstrated overall improvements in abduction PROM. There was also significant improvement in ER PROM following EBI in conjunction with surgery. Prolonged immobilisation in IR may result in restricted ER ROM, which may have prompted a greater focus on improving ER ROM, and explain the ER PROM improvements.

Additionally, the secondary comparison between standard EBI and multimodal EBI AROM outcomes showed significantly better results following multimodal EBI. The multimodal EBIs included strategies such as neuromuscular exercises[9] and elastic resistance training combined therapeutic ultrasound.[34] While beyond the scope of our study, these findings raise interest in the mechanisms underlying the greater efficacy demonstrated by multimodal EBI, and opportunities to maximise outcomes of ASD patients through conservative management.

Limitations

This study has some limitations. Initially, our search was restricted in several ways (ie, four databases, from 1990 and in English language only). Given the databases that we selected, our search not only included the academic peer-reviewed literature but also the grey literature (ie, via Web of Science and Google Scholar). Most articles in this area were published since 1990 and hence the bias with the selection of databases and date limitations is considered low. By selecting English language only, we acknowledge the potential of selection bias. Future studies would benefit from not restricting to English only, particularly given a range of translation options now available. Second, EBI for ASD is multifaceted, and can include combinations of shoulder strengthening, mobility, proprioception and endurance training approaches. It is possible that differences in EBI methodology contributed to different effects on outcomes, and this may explain the considerable heterogeneity demonstrated in the present analysis, which ranged from low to high (I^2=0%–89.21%), with >75% rated as high.[93] The components and dosage of EBI varied depending on the patient goals and level of performance. There is no consensus on, or an established clinical practice guideline, for prescribing EBI to ASD patients. Hence, the impact of EBI observed in this study may be influenced by the training level and preinjury status of the affected individual. For example, prolonged morbidity secondary to rotator cuff tear is more prevalent in older than in a younger population.[94] Additionally, the follow-up times of the included studies varied from as low as 3 weeks to as high as 7 years. This was another factor that may have contributed to the considerable heterogeneity. Nevertheless, only comparable studies were included in this review, which is a strength of the assessment of EBI on functional outcomes post-ASD. While this review included more studies than a previous meta-analysis by Longo *et al*,[73] only a few studies included specific settings (athletic, occupational, motor vehicle accidents etc), which may affect the translation of our findings to different contexts. There is evidence of certain measures (eg, WOSI, Oxford Shoulder Score) being specific and sensitive to measuring changes in the ASD population however, the majority of the self-report measures included in our analysis need further investigation.[95] As such, these measures may have limited ability to detect changes between groups (ie, EBI in conjunction with surgery, and EBI alone); and is important context when interpreting these findings.

Further to the above limitations regarding characteristics of the included studies, our analysis was limited by a number of key factors. One, studies that included a head-to-head analysis (ie, experimental in design) were few and included low sample sizes with substantial heterogeneity in their features and outcomes. Two, carrying out a random effects analysis (using the Sidik-Jonkman model) was able to highlight some important findings in relation to non-recurrence, RTA, self-report measures and functional measures, however, was predisposed to 'sparse data bias'[26 27 96] as only a certain number of studies could be included in the analysis. Further, data were not always normally distributed, and alongside the sparse data bias, further options such a subgroup analyses, meta-regression and investigation of non-reporting bias were outside the scope of this review. Lastly, the tertiary findings on the success of multimodal EBI for ASD were based on limited number of studies.

Our findings highlight a need for future studies to clearly describe EBI parameters such as number of sets and/or repetitions, intensity, and session duration and frequency—enabling direct comparison of dose–response effects on function post-ASD. Given that multiple components make up a typical EBI for ASD, the aforementioned factors require additional investigation, to assess whether (and to what extent) these determinants of EBI influence outcomes.

IMPLICATIONS FOR PRACTICE, POLICY AND FUTURE RESEARCH

This review assessed the effectiveness of EBI in conjunction with surgery compared with EBI alone for ASD. Following EBI in conjunction with surgery, recurrence rates were lower and there was more successful RTA. Together with improvements in self-reported outcomes, strength and ROM, these findings show the clinically meaningful effects of EBI in conjunction with surgery for ASD; and provide evidence to directly inform clinical management decisions. In terms of management following ASD, this review provides evidence that further supports a combined surgical and EBI approach. Although there is evidence that multimodal EBI may provide additional benefits beyond standard rehabilitative practice, further research investigating such methods is required. Despite the low certainty of evidence, recommendations can be made for increased implementation of EBI in conjunction with surgery for the management of ASD.

Twitter Rutger M J de Zoete @DrRdeZoete and Timothy Lathlean @TimLathlean

Contributors TL conceived and designed the research project. VC and TL searched and screened the studies. VC and RMJdZ carried out the risk of bias assessment. CD and TL carried out the data extraction. TL analysed the data and interpreted the results of the analysis, over successive revisions and is responsible for the overall content as the guarantor. All authors drafted the manuscript and assisted in the interpretation of the data. All authors critically reviewed the manuscript, provided significant input to the initial submission and subsequent revisions and approved the final version.

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ORCID iDs
Rutger M J de Zoete http://orcid.org/0000-0002-0273-3377
Timothy Lathlean http://orcid.org/0000-0001-7340-1567

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Supplemental Table 1 Search strategy for PubMed (Medline) February 2023

Search Number	Query	Results
1	(anterior AND shoulder AND dislocat*).mp	3,609
2	warm up exercise [MeSH terms]	457
3	warm up.mp OR (warm AND up).mp	7,866
4	#2 OR #3	7,866
5	(Muscle AND stretching AND exercise*).mp	3,292
6	(Resistance AND train*)	30,544
7	Plyometric*	1,579
8	proprioception [MeSH terms]	8,788
9	Propriocept*	17,534
10	#8 OR #9	17,534
11	Exercise therapy [Mesh TERMS]	48,213
12	(Exercise AND therap*)	134,231
13	#11 OR #12	134,231
14	#12 OR #10 OR #7 OR #6 OR #5 OR #4	185,017
15	#14 AND #1	204

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
Abdelshahed et al, 2018	10	9 males, 1 female. Mean age: 30 years	Retrospective	Immobilization 4 weeks PROM/AAROM from 4 weeks AROM 8 weeks Resistive strength from 3 months - progress as tolerated High-risk activities (sports) avoided after 6 months/ verification full incorporation of bone graft on radiographs. Control: -	ASES, WOSI,Abduction ROM, Forward flexion ROM, ER ROM at 90 degrees, ER with arm by the side	4.5±2.5 years (Range: 2.3-9.1 years)	14/28
Aboalata et al, 2017	104	Not reported.	Case series	Customized rehabilitation program to address scapular dyskinesis, subjective apprehension and limited range of motion. Treatment continued until symptom relief. Control: -	Redislocation and risk factors for redislocation, ASES, Constant score, Rowe score, Dawson 12-item questionnaire, American Academy of Orthopedic Surgeons (AAOS) score, Strength,	13 years	19/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
					Visual Analog Scale (VAS)		
Ahmed et al, 2020	5	Age: 40-50 years	Experimental	Set of therapeutic exercises aimed at treating and improving the shoulder joint by strengthening muscles and ligaments of the shoulder joint. Abdominal rehabilitation exercises	ROM, IR, ER, Abdominal muscle and grip strength	12 weeks	9/28
Ali et al, 2016	29	Age: 25-52 years	Comparative	The physical therapy program consisted of three phases Phase I: Immediate Post-Surgical Phase that lasted	Shoulder function (Pain severity, range of motion and muscle strength was quantified). Proprioception acuity was measured using	2 weeks, 15 weeks	17/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				approximately for 3 weeks. The major goal during this phase was to maintain the integrity of the surgical repair. Therapeutic interventions aimed at minimizing shoulder pain and inflammatory response as well as restoring passive range of motion (PROM) and scapular function. Interventions included cryotherapy to decrease pain and inflammation, wearing an arm sling to allow adequate bone healing and exercises. Exercises in the form of passive range of motion (PROM) for shoulder	the closed kinetic chain upper extremity stability test (CKCUET)		

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				external rotation (ER) and internal rotation (IR), Active Assisted Range of Motion (AAROM) for shoulder flexion and abduction, and active range of motion (AROM) for elbow and wrist. In addition, patients received scapular clock exercises progressed to scapular isometric exercises and ball squeezes. Patient education on posture and shoulder protection Phase II– Intermediate Phase/ROM. 4-9 weeks. Gradual restoration of AROM and to allow weaning from immobilization. During this phase			

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
				patients were allowed to begin light waist level activities by the end of week 4. Glenohumeral joint mobilization (Grade I & II) scapulothoracic and thoracic spine joint mobilizations (Grade I III) and posterior capsular stretching rhythmic stabilization, strengthening of scapular retractors and upward rotators and balanced AROM / strengthening program. Phase III - Strengthening Phase: Week 10-15. Normalize strength,			

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				endurance, as well as neuromuscular control. Full functional activities to chest level were restored. Anterior joint capsule was gradually stressed through biceps curls with light resistance. Gradual and progressive strengthening of pectoralis major and minor and subscapularis musculatures.			
Alam et al, 2017	20	Group A: Elastic band and Ultrasound treatment Average age (SD): 27.8 (7.61)	Randomized controlled trial	Elastic band group: Shoulder flexion, abduction, external rotation with 3s eccentric contraction: 10-12 reps	Flexion, Abduction ROM, SPADI, Pain intensity	21 days	21/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
		Group B: Hot pack and manual exercises Average age (SD) 28.2(7.8)		2-minute break after each set Manual exercise group: Pendulum exercises, wall crawl, ROM exercises: 10-15 reps 5 days/week			
Amako et al, 2017	79	Not reported	Case series	Immobilization for 3 weeks. Isometric exercise in the sling. 2 weeks: ROM exercises. 3 weeks: Removal of sling, active flexion in supine, passive external rotation 4 weeks: Rotator cuff strengthening using elastic resistance 6 weeks: Resume activities of daily living	Weighted standardized peak torque, Ipsilateral Peak Torque ratio for shoulder rotators, Contralateral Peak Torque ratio, Isokinetic shoulder muscle strength measured at 45 degrees of abduction with elbow flexed to 90 degrees, Rowe score, Japanese	3,6,9,12,24 months	16/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				8 weeks: Upper limb strengthening using <2 kg dumbbell 12 weeks: Push-ups permitted 2-3 months: Non-contact sports 6 months: Contact sports and overhead activities permitted.	Orthopedic Association (JOA) score, DASH		
Arciero et al, 1994	36	Group 1: non-operative treatment N=15 Mean age: 19.5 years (Range: 18-21 years) Group 2: Arthroscopic Bankart Repair N= 21 Mean age: 20.5 years (Range: 18-24 years)	Experimental	Group 1: Shoulder immobilization for 4 weeks. Supervised rehabilitation consisting of rotator cuff stabilization with emphasis on subscapularis muscle, scapular stabilization exercises. Return to full activity at 4 months Group 2: Arthroscopic Bankart repair followed by rehabilitation same as group 1	Recurrence rate.	23 months (Range 15-39 months)	19/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
Aronen et al, 1984	20	19 males, 1 female Mean age: 19.2 years Age range: 18-22 years	Experimental	Initial phase: 3 weeks of immobilization, analgesics and restriction of activity. 2 weeks: Pain-free isometric exercises for internal rotators and adductors progressed to isotonic exercises, tubing exercises. 3 weeks: Isokinetic strengthening of internal rotators and adductors 4-5 weeks: Complete shoulder rehabilitation-internal rotation, external rotation, flexion, extension, abduction, adduction Control: -	Recurrence rates, Average time before full return to sports.	35.8 months (Range: 17-45 months).	13/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
Augustsson et al, 2012	121	26 females (Age range: 14-58 years, Mean: 34 years) 95 males (Age range: 16-57 years, Mean: 32).	Observational	Immobilization 4 weeks post-op w/ brace and arm at side Free flex and INT Rot allowed from day 1 post-op Rehab: active ex to regain normal AROM and flexibility of shoulder muscle, free ROM in all directions permitted. Included dynamic strengthening exercises for rotator cuff to restore muscle strength and functional capacity Return to activity at 6 months Throwing and contact sports allowed at 6 months Control: Pre-operative vs Post-operative	Muscle strength, ROM, HRQOL	6 months; 7-8 years	19/28
Buss et al, 2004	30	24 males, 6 females	Prospective study	No immobilization. ROM exercises, wand exercises,	Recurrence, Return to sports	2 years	14/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
		Mean age: 16.5 years Age range: (14-20 years)		strengthening of rotator cuff with free weights <1 lb. Periscapular strengthening. Duke-Wyre brace on return to play for non-overhead athletes, Sully brace for overhead athletes.			
DeBerardino et al, 2001	57	Arthroscopic repair group: 45 men, 3 women Average age: 20 years (Range: 17-23 years) Non-operative group: N=6 Primary open repair group: N=3	Prospective study	Immobilization for 3 weeks. Restrengthening program focused on shoulder internal rotators and adductors. Progressions from isometric to isotonic to isokinetic. Return to full activity at 3 months.	Detailed arthroscopic findings, Rowe score, SF-36, Single Assessment Numeric Evaluation (SANE), post-operative serial radiographs.	5 years	13/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
Dickens et al, 2017	45	39 males, 6 females Mean age±SD: 20.6±1.63 years	Cohort study	Post-operative treatment: Immobilization for 6 weeks 3 months: Range of motion exercises 6 months: Return to sports Control: Non-operative vs Surgical stabilization	Return to sport without recurrent instability	Not specified.	18/28
Edmonds et al,2003	24	Surgery group: 9 males, 2 females (Mean age: 20.79±2.53, Range: 17.05-24.87 years) Traditional group: 12 males, 1 female (Mean age: 21.95±3.91, Range: 15.46-28.34 years)	Randomized controlled trial	Stage 1: 0-3 weeks: immobilization, 4-6 weeks assisted AROM, EXT rot 20 degrees past neutral, pendular exercises, scapular retractions Stage II: 7-8 weeks: active ROM, isometrics, EXT rot limited to 45 degrees past neutral Stage III: 9-12 weeks: AROM with terminal stretch, isotonics,	Threshold to detection of passive movement (TTDPM) > for surgical treatment group but not significant	3 months	24/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				scapular strengthening, 3 months - noncontact/non-overhead sports RTW, 4 months contact sports. Control: Arthroscopic stabilization and rehabilitation vs Standard immobilization and rehabilitation.			
Ellenbecker et al,1999	20	13 males, 7 females (Mean Age±SD: 24.5±8.48).	Single session post-test	**Phase I:** immobilization, aim to control pain and swelling, ROM of elbow, forearm, wrists, scapular mobilization, strengthening for elbow, forearm and wrist **Phase II:** Sling removed, AROM and	ROM, Unilateral ER/IR strength ratio.	12.03±2.05 weeks (Range: 9-15 weeks)	16/28

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
				PROM of G-H joint, PROM 100 to 120 degrees of flexion, abduction and scapular plane elevation, 45 degrees EXT Rot and full INT Rot, posterior glides of humeral head, submax isometrics for INT Rot, and Ext ROT, resistive ex for the shoulder low resistance high reps (3x15), upper body ergo - ROM, scap motion, strengthening **Phase III**: 1 month post-op, addition of AROM and PROM to terminal ranges in all planes, focus on posterior capsular stretch, posterior glide of humeral head, isotonic ex initiated - using movement patterns with high levels of rot cuff			

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				activity (EMG), rubber tubing for IR and ER and scapular retract/protract, upper-extremity plyometrics (SSC) initiated with Swiss balls progressing to 2lb-6lb med balls using chess-pass skill pattern, ex shoulder weight bearing on swiss balls, baps boards and quadruped/triped stance positions **Phase IV:** all phase III ex, isokinetic ex in movement pattern of IR and ER, 10-12 weeks post op, requires full ROM, tolerance to isotonic rotator cuff and scapular resistive ex programming, increase ROM and isotonic/isokinetic rot cuff/scapular strength			

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				12-th to 16th weeks post op. Strength of rot cuff in 90 degrees of glenohumeral joint abduction. Return to throwing or overhead (tennis/volleyball) when isokinetic strength with 10% of contralateral limb for int and int rot, functional ROM reattainment, negative impingement tests, muscle tendon provocation tests. Control: -			
Eren et al, 2019	54	49 males, 5 females Average age: 30.5±9.1 years Home-based group: N=33 Hospital based group: N=21	Non-randomized controlled trial	Phase I: Maximum protection phase Sling immobilization for 4 weeks, table top activities, Isometric deltoid strengthening, postural exercises with sling,	DASH, Constant, Rowe score	1 year	18/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				Elbow, wrist, finger ROM. Phase II: Limited motion phase (5-8 weeks) Passive shoulder ROM, AAROM with L bar and pulley Isometric, IR, ER, Scapulothoracic Phase III: Medium protection phase (9-12 weeks) AROM, Isotonic flexion, IR, ER, extension exercises Phase IV: Minimum protection phase (13-21 weeks) Capsular stretching, Progressive resisted			

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				strengthening of rotator cuff, Closed kinetic chain scapular stabilization exercises, plyometric exercises at week 16 Phase V: Functional phase (22 weeks and later) Functional strengthening, proprioceptive and plyometric exercises.			
Eshoj et al, 2019	56	Primary anterior shoulder Dislocation (PASD) N=34 (28 males, 6 females) Recurrent anterior shoulder Dislocation (RASD)	Cross-sectional study	**SINEX:** NM ex including strength, coordination, balance, proprioception, integrated various body positions enhancing compensatory functional shoulder stability. 12 weeks individually tailored, supervised session of	WOSI,CMS, glenohumeral joint hypermobility, shoulder joint position sense	12 weeks	18/28

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
		N=22 (21 males, 1 female) Mean age: 26 years		progress shoulder ex in addition to functional kinetic chain ex.			
Eshoj et al,2020	56	56 patients with age range of 18-39 years.	Randomized controlled trial	**SINEX:** NM ex including strength, coordination, balance, proprioception, integrated various body positions enhancing compensatory functional shoulder stability. 12 weeks individually tailored, supervised session of progress shoulder ex in addition to functional kinetic chain ex. **HOMEX:** strength training predominantly 7 ex targeting G-H and scap muscles; 7 progression levels (basic to elite) with ex	WOSI, Return to activity	12 weeks	20/28

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
				at basic performed every day (2x20 reps) and at elite 3 times weekly (2 x 10 reps). Followed general strength training principles, with basic and elite referring to low and high load ex. 1 intro session plus leaflets. Instructed to not perform ex that exceeded pain limt/ provoked shoulder pain. Active ex for rotator cuff/scap suing elastic bands 1 ex for mobility/coactivation of scap and core stability muscles. 3 x weekly 2 x 10 reps for 12 weeks. Control: Shoulder Instability Neuromuscular Exercise			

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				Vs Home-based standard shoulder exercise program.			
Fabbriciani et al, 2004	60	Arthroscopic repair (n=30): 24 males, 6 females Mean age: 24.5 years Age range: 19-33 years Open repair (n=30): 26 males, 4 females Mean age: 26.8 years Age range: 21-30 years	Prospective randomized clinical study	Immobilization in a sling in 20 degree forward flexion, 30 degree abduction for 6 weeks. After 3 weeks: Passive and active assisted range of motion exercise 3 months: Advanced muscle strengthening, capsular stretching 6 months: Return to sports. Control: Arthroscopic repair vs Open procedure	Constant Score, Rowe score, ROM	2 years	20/28

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
Gaballah et al, 2017	12	12 males (Mean age±SD: 18.6±1.32 years).	Pretest posttest design	6 week rehab: **Stage 1:** 0-2 weeks, 17 ext, int rotation aim control pain and inflammation, flexibility isotonic strength ex 12-15 resp 30% 1 RM, scapulothoracic parti rotat cuff **Stage 2:** 3-4 weeks, restore higher level of muscle strength, intensity 5 sets 8-10 reps 60-70% 1RM, 32 ex - deltoid, trapezius, serratus anterior, horizontal/diagonal axes, aimed to increase ROM and muscle strength between 90 and 150 degrees vertical, horizontally and diagonally **Stage 3:** 5-6 weeks., endurance, plyometric strength ex: 5 sets 3-6	ROM	6 weeks	18/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				reps 70% 10RM, 2 at 95% 10RM, 27 ex weights rehab ex to reach 190 to 2000 degrees ROM, theraband resistance during 6 weeks. Control: Pre vs post exercise program.			
Gasparini et al, 2016	143	128 males, 15 females	Prognostic study	Immobilization in 10 degrees of abduction for 4 weeks. AROM of elbow, wrist, pendulum exercises of the shoulder. Brace removal at 4 weeks, passive mobilization initiated. At 6-8 weeks, progressive AROM. Return to activity at 5 months	Recurrence, Rowe Score	81 months (Range: 24-172 months)	18/28
	34		Prospective single surgeon series	**Phase 1:** 0-4 weeks Active assisted	Time to regain elevation ROM,	6 weeks	16/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
Gibson et al, 2016		Mean age: 23 years, Age range: 17-33 years.		mobilization within safe zone, proprioceptive exercises, isometrics of the rotator cuff and scapular muscles, use of sling **Phase 2** 3-10 weeks: Progress cuff and scapular muscle strengthening into risk positions and add load, closed kinetic chain work in risk positions, opposite arm strengthening **Phase 3:** 6-16 weeks: Plyometrics, Neuromuscular work, controlled falling drills, return to full training Control: -	Time to regain ER ROM, Time to return to play, Recurrence.		

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
Gigis et al, 2014	72	non-surgical group: 17 males (Mean age: 16.4 years), 10 females (Mean age: 16.9 years). Operative group: 24 males (Mean age: 16.8 years), 14 females (Mean age:16.3 years)	Prospective comparative study	Same protocol for arthroscopic and non-surgical groups. In 1st 3 weeks arm was immobilised in sling with only passive therapy. External rotators with arm by side and elbow flexed was allowed - e.g encouraged to write. Active elbow, wrist and hand motion was allowed week 8 active treatment to restore ROM of joint > 8 weeks, patients permitted full ROM of joints 12-week, ex for strengthening began and return to sports involving shoulder allowed 5th month post-injury.	Recurrence rate, instability evaluation, return to activity	36 months	16/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				Control: Early arthroscopic stabilization vs Non-surgical treatment.			
Hajewski et al, 2019	72	Longitudinal analysis: Mean age: 22.1 years (Range: 14-44 years) 79% males Cross sectional analysis: Mean age: 24.8 years (Range: 17-56 years) 80% males	Cohort study	Physical therapy commenced at 2 weeks postoperatively, AROM and resisted isometric exercises by 6 weeks. Multicenter Orthopedic Outcome Network (MOON) protocol followed.	ASES, Marx shoulder activity scale, SF-36, PF, SF-36 GH, WOSI, PROMIS PF CAT, PROMIS UE	6 weeks, 6 months, 2 years.	16/28
Hatch et al,2018	21	19 males, 2 females Mean age: 16 years Age range: 14-18 years	Retrospective study	Immobilization for 4 weeks. 2 weeks: Codman exercises initiated. 4 weeks: Progressive resistance strengthening exercises of dynamic stabilizers of the shoulder and	Rowe score, UCLA score, Return to previous level of sports, External rotation range of motion, Recurrence	2 years	12/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				periscapular muscles. Progressive range of motion exercises, strengthening rotator cuff and scapular muscles. 5 months: Return to sports.			
Jakobsen et al, 2007	76	62 males, 14 females. Repair group (n=37): Mean age: 23 years Age range: 15-39 years, 7 females, 30 males Non-surgical group (n=39): Mean age: 20 years	Randomized controlled trial	Nonfixed sling for 1 week - then rehab including PROM. Avoid rotating, lifting, pushing At 3 weeks postop - AROM (IR and abduction) After 8 weeks - ER introduced After 12 weeks - swimming and light sports From 6 months overhead sports.	Recurrence, Oxford scale	24 months	16/28

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
		Age range: 15-31 years, 7 females, 32 males.		Control: Primary surgical repair vs Non-surgical treatment			
Kelley et al, 2021	62	52 males, 10 females Mean age: 18.7 years Range: 16-24 years	Case series	Immobilization for 4 weeks, Active and passive elbow ROM, shoulder forward flexion, At 5-12 weeks: progressive ROM exercises, muscle strengthening initiated. Forward flexion at 6 weeks, ER in neutral at 8 weeks and ER in scapular plane at 8-12 weeks	WOSI, SANE, ASES, TSK-11,	2 years	17/28
Khan A et al, 2014	49	Non-operated(n=25): 14 males, 11 females Mean age±SD: 22±3.9	Retrospective series	Group 1 (non-surgical treatment): manipulative reduction and Immobilization in arm sling in INT Rot 3-4 weeks, shoulder rehab 6-8 weeks. Group 2 (Surgical	Recurrence, Complications following surgery, Return to sport	5 years	12/28

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
		Operated group (n=28): 21 males, 7 females Mean age±SD: 25.3±4.3		Treatment): open Laterjet's procedure, immoblisation in INT Rot for 3-4 weeks, shoulder rehab daily 6-8 weeks. Control: Non-operated vs Operated			
Kim D et al, 2011	310	Primary dislocation (n=42) Mean age: 24.2 years Age range: 17-34 years Recurrent dislocation (n=68) Mean age: 27.8 years Age range: 18-38 years	Observational	Immobilization in abduction orthosis for 4 weeks. Day 1 post-operatively: Isometric and passive anterior flexion exercises. 2 weeks: Progressive extension exercises 3 weeks: Assisted active exercises. 6 weeks: Therababnd and dumbbells to	Magnetic Resonance Arthrography (MRA), Pain, Constant scores, Rowe scores, Arthroscopic findings, Surgical correlation	Not specified.	16/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				strengthen shoulder musculature. 12 weeks: Resistant muscle reinforcing exercises 6 months: Return to sports. Control: Primary dislocation vs Recurrent dislocation			
Kim Y et al, 2019	3	Subject 1: 28 years Subject 2: 22 years Subject 3: 64 years	Case series	**1st month:** PROM AROM (flexion, ER, IR), as tolerated >3 times per day. **2nd phase:** light intensity RT (tubing flexion, ext, ER/IR), band resistance increased as tolerated. Strength 10 trials held 5 sec, each direction 2-3 x per day, static weight bearing in neutral and in 45 and	Strength, ROM, Pain intensity on VAS	1 month, 3 month, 6 month	12/28

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
				90 degrees of abd, target anterior delt, pec major, long head biceps. Avoided overhead movements. **3rd phase:** RT using weight machines: Chest, shoulder, butterfly bench press. RT at low reps, low weight, slow speeds through restricted ROM, progressing to increased reps, higher weights, greater speed. Large-angle joint movements with RT performed by exerting power slowly. **4th Phase:** lat dorsi pulldowns, push ups on gym ball and plyometric ex to enhance dynamic shoulder stability and			

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				more targeted functional exercises.			
Kirkley et al, 1999	40	35 males, 5 females Mean age: 22.4 years	Prospective randomized clinical trial	Weeks 0 to 3 Immobilization in a sling Stage I: 4 to 6 weeks Active assisted ROM External rotation limited to 20 degrees past neutral Pendular exercises Scapular retractions Stage II: 7 to 8 weeks Active ROM Isometric exercises External rotation limited to 45 degrees past neutral Scapular exercises/retraining Stage III: 9 to 12 weeks Active ROM with Terminal Stretch	Rate of redislocation, Quality of Life (WOSI), ROM	32 months	23/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				Isotonics Scapular strengthening 3 months Noncontact/non-overhead sport Return to work 4 months Contact sports. Control: Traditional therapy vs Arthroscopic stabilization			
Larrain et al, 2001	46	Average age: 21 years (Range: 17-27 years) Most participants were rugby players (n=36) Non-operative treatment: n=18	Prospective non-randomized study	0-2 weeks: Elbow ROM exercises 2-4 weeks: Pendular exercises. 4-8 weeks: Single plane movements including arm elevation. 8-12 weeks: Multiplanar movements, abduction with external rotation.	Redislocation, Rowe score, Intraarticular lesions	67.4 months (Range: 28-120 months)	14/28

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
		Acute arthroscopic repair: n=28		12-16 weeks: Progressive resisted exercises for the shoulder. >16 weeks: Return to sport			
Lee JH et al, 2020	6432	Instability group (n=32): 29 males, 3 females Mean age±SD: 25±5 years Control group (n=32): 27 males, 5 females, Mean age±SD: 25±1 years	Case-control	12-week rehabilitation: Immobilization with abduction brace for 4 weeks after A/S Bankart repair 4 weeks post PROM AAROM and AROM ex gradually started - aim to restore full AROM by 12 weeks 6 weeks neuromuscular retraining 8 weeks shoulder strengthening, including periscapular musculature, 12 weeks shoulder strengthening in 90 degrees ABD, home program including RT,	NM control index (time to peak torque and acceleration time) and muscle endurance Muscle strength ratio/ muscle strength of operated shoulders before and after A/S Bankart repair	Yearly upto 6 years	24/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				neuromuscular control, proprioception 6 months: return to noncontact sports and gradually allowed unrestricted activities in sports. Control: Patients who underwent Bankart repair vs Asymptomatic volunteers			
Martinez et al,2018	70	Phone assistance program group (n=36) Conventional postoperative management group (n=34)	Randomized controlled study	3 weeks of immobilization in a sling. Home exercises, upper body motion, additional coaching for self-care for the phone assistance group.	ROM, Pain on VAS, DASH, Oxford Shoulder Instability Score and Rowe score	12 months	19/28
Moser et al, 2008	110	49 males, 44 females Mean age±SD: 24±8.9 years,	Comparative study	Patients were treated by 1 shoulder physiotherapist with an individualized, progressive exercise program. Exercises	Oxford Instability Shoulder Score, Shoulder Rating Questionnaire	1,3 and 9 months	18/28

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
		Age range: 11-67 years		were directed at optimizing neuro-muscular control and strength in relation to the patients' functional demands.5,28,32,38,42 All patients were given a home exercise program and seen 4.5 times on average. Control: Oxford Instability Shoulder Score [OISS] vs Shoulder Rating Questionnaire [SRQ].			
Multanen et al, 2020	45	Exercise group (n=23): 16 males, 7 females Mean age±SD: 36±11 years Control group (n=23): 16 males, 7 females	Randomized controlled trial	Comprehensive rehab as outlined in paper. Same rehab for first 1 months: operated arm in sling for 3 weeks, light ADLS with sling Post op home ex protocol: 3 x per day Experimental group 2 months post op: advise/instructions at	VAS, ASES, SF-36, ROM and strength	6 months	24/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
		Mean age±SD: 34±10 years		Out-patient clinic on shoulder strengthening ex at home (REFS Kibler 2001, Wilk 2002), ex 3 x per week for 12 months. Control: Exercise group vs Usual care			
Naughton et al, 2005	30	Dislocator group (n=15): 14 males, 1 female Mean age±SD: 22.4±4.8 years Control group (n=15): 9 males, 6 females Mean age±SD: 23.5±8.19 years	Pre and post measures	a 10 min program throughout the month of intervention. Each subject was given a Swiss ball and a wobbleboard to use and asked to maintain balance while lying on the ball. The dislocator group undertook upper-body wobble board training for 10 min each day for 5–6 days per week for the month. Control:	Movement discrimination test perceived stability and strength	1 month	14/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				Individuals with anterior shoulder dislocation vs Uninjured Control			
Netto et al, 2012	50	Open repair (n=25): 21 males, 4 females Arthroscopic repair (n=17): 16 males, 1 female	Randomized controlled trial	Immobilization in a sling for 3 weeks. 3 weeks: Active, passive elbow ROM, shoulder passive ROM upto 0 degree external rotation and 90 degree abduction in scapular plane 4 weeks: Immobilization discontinued, progressive range of motion. 16 weeks: Discharge from physiotherapy 24 weeks: Return to sports.	DASH, UCLA, Rowe scores, Shoulder ROM on affected side, Adverse events	37.5 months (Range: 20-56 months)	21/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				Control: Open repair vs Arthroscopic repair			
Park et al, 2019	51	Mean age: 20.9 years Age range: 19-27 years	Case series	Postoperatively, each patient's arm was kept in a sling that allowed 30° of abduction for 5 to 6 weeks. Isometric exercise of the scapular muscles, grip power strengthening, and elbow range of motion exercise were allowed during the first 5 to 6 weeks of immobilization. Rehabilitation exercise was started at 5 to 6 weeks, which involved gentle passive forward flexion using a pulley. An external rotation exercise using a stick was introduced 9 to 10 weeks post operatively. Strengthening exercises with	Return to play, solid return to play	24 months	20/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				TheraBand and light weight lifting were permitted at 12 weeks. Daily activity without restriction was allowed 5 to 6 months postoperatively, and return to sports (including contact and collision sports) was allowed according to different positions and throwing/nonthrowing arm.			
Peltz et al, 2015	22	Mean age±SD: 20.5±4.9 years Age range: 16-29 years		The postsurgical rehabilitation program consisted of 3 phases: **Immediate postoperative** (weeks 0-6), ROM restoration (weeks 6-12), and strength training (weeks 12-24). The	Strength ROM Patient reported outcomes		23/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				first phase consisted of immediate absolute immobilization for 0 to 4 weeks followed by relative immobilization in which limited ROM exercises were performed. In the **second phase**, passive ROM exercises and limited active ROM exercises were performed, with the goal of restoring normal ROM, increasing strength, and improving scapular stabilization. The goal of the **third phase** was to increase strength and endurance, resulting in full return to activities of daily living, work,			

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
				and recreational activities. Control: Anterior instability patients vs Healthy controls.			
Porschke et al, 2020	23	20 males, 3 females Mean age±SD: 56.4±6.3 years	Retrospective case series	Immobilization in a shoulder abduction ortho sis at 30° for 4 weeks. Pain-free, passive range of motion up to 90° abduction and flexion and 40° internal/external rotation (IR/ER) was started on the first day post-surgery. Active motion restricted at 90° abduction and flexion, and 40° IR/ ER rotation was allowed after 4 weeks. Active range of	Constant Murley Score, DASH Score and Rowe Score	58.2±32 months	22/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				motion on all ranges was allowed after 6 weeks. Strength training for rotator cuff, deltoid and scapula stabilizers was gradually increased beginning at 6 weeks postoperative. Three months after surgery, carrying weight and non contact sports were allowed. After 6 months the patients were allowed to return to sports without restriction.			
Pulido et al,	37	Group 1:Traditional N=12 Mean age: 19.9 years Group 2:Body blade N=12	Randomized-controlled longitudinal training study	8-week intervention, 3 times a week **Traditional:** The Traditional protocol included four elastic resistance band exercises: 1) shoulder adduction, 2) shoulder	WOSI, UQYBT	12 weeks	17/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
		Mean age: 19.8 years Group 3:Mixed N=12 Mean: 20.2 years		extension, 3) shoulder abduction and 4) bilateral row. **Bodyblade group:** The Bodyblade™ exercise protocol consisted of shoulder internal and external rotation (IR/ER) at 65° (transverse plane: longitudinal axis), shoulder flexion at 90° (sagittal plane: mediolateral axis), shoulder abduction at 90° (frontal plane: anteroposterior axis), and shoulder flexion at 180° (sagittal plane: mediolateral axis)			
Rhee SM et al, 2021	104	89 males, 15 females Mean age±SD: 26.8±10.7 years	Case series	Home-based physical therapy protocol was prescribed for all patients The shoulder was supported for 4 to 6	Peak Torque deficits, Isokinetic muscle performance, ASES, Rowe, pain on VAS.	1 year	9/28

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
		Age range: 15-69 years		weeks in neutral rotation with a brace No passive motion was allowed, active hand, wrist, and elbow exercises with shrugging were permitted. Active shoulder stretching exercises including active/ active-assisted range of motion after brace removal. After the restoration of mobility,strengthening exercises with Thera Band were started at 3 months strengthening exercises involving forward flexion, ER, and IR with the lowest level of resistance. These 3 exercise sets were performed 3			

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				times a day, with 10 repetitions each time. The proper level of resistance was checked at the follow-up visit. Regular sports activities were usually permitted 6 months post-surgically. Control: -			
Rhee YG et al, 2007	40	Glenoid defect group (n=20): 19 males, 1 female Mean age: 28 years Age range: 17-37 years Control group (n=20):	Prospective	0-3 weeks: Passive shoulder Exercises--90° flexion and 0° external rotation as well as isometric exercises of the rotator cuff and deltoid muscles From 6 weeks postoperatively, active shoulder exercises were carried out. Excessive abduction and external rotation	Pain, ROM, Stability, Patient satisfaction, Rowe Score.	48 months	14/28

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
		16 males, 4 females Mean age: 23 years Age range: 18-39 years		were gradually introduced according to the results of the patient's apprehension test. Control: Patients with glenoid defect vs patients without glenoid defect.			
Robinson et al, 2006	252	225 males, 25 females Age range: 15-35 years	Prognostic study	Immobilization in internal rotation, neutral flexion, neutral abduction for 4 weeks. Pendulum exercises during first 4 weeks, elbow ROM 4-6 weeks: Active assisted shoulder ROM, avoid elevation and abduction beyond 90 degrees or external rotation beyond 30 degrees.	Recurrent instability, DASH, SF-36, WOSI, ROM:External rotation in neutral abduction , External rotation at 90 degree abduction, Internal rotation at 90 degree abduction.	6 weeks, 3 months, 6 months, 1 year	16/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				6-12 weeks: Unrestricted ROM in abduction or external rotation, isometric rotator cuff strengthening, isotonic exercises at 12 weeks 12 weeks: General fitness training, running, non-contact sports etc 6 months: Return to sports. Control: -			
Robinson et al, 2008	88	Arthroscopic Bankart (n=45): 42 males, 3 females Mean age±SD: 24.3±4.6 years	Single-center double blind Clinical trial	Immobilization with sling in internal rotation, neutral flexion and neutral abduction for 6 weeks. After arthroscopic procedure passive circumduction exercises, elbow ROM	Primary: Redislocation Secondary: DASH, SF-36, WOSI, ROM, Economic evaluation of cost of treatment	6 weeks, 3,6 months, 1 year, 2 years	24/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
		Arthroscopic Lavage (n=43): 40 males, 3 females Mean age±SD: 25.3±4.8 years		6-12 weeks: Active assisted shoulder ROM exercises, no elevation or abduction beyond 90 degrees or 30 degrees ext. rotation. Isometric rotator cuff strengthening. 12 weeks: Isotonic exercises, general fitness training, running. 6 months: Return to sports. Control: -			
Roth et al, 2020	67	Dominant side instability group (n=36): 24 males, 12 females Age median: 26 years	Prospective non-randomized	Postoperatively, patients were placed in an arm sling-type Gilchrist bandage for 6 weeks (Basel cohort) or 3–5 weeks (Vienna cohort). Patients of the Basel cohort started passive	Rowe score, VAS	33 months for dominant side and 41 months for non-dominant side.	20/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
		Non-dominant side group (n=31): 26 males, 5 females Age median: 26 years		mobilization under physiotherapeutic surveillance immediately after surgery with limits of the range of motion (ROM) of 30° abduction and flexion for 2 weeks, 60° abduction and flexion for the subsequent two weeks, and 90° abduction and flexion for another two weeks. During those 6 weeks, the external rotation was limited to 0°. After 6 weeks of passive mobilization, full ROM and initiation of strengthening exercises was started. Patients of the Vienna cohort			

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				started active-assisted mobilization after three weeks of immobilization under physiotherapeutic surveillance with ROM limits of 30° external rotation for three weeks, and 60° external rotation for subsequent 2 weeks. Full ROM and initiation of strengthening exercises started in the 9th week postoperatively. Control: Dominant side instability vs Non-dominant side instability.			
Roulet et al, 2019	300	222 males, 78 females Mean age±SD: 25.1±7.9 years	Retrospective	Immobilization for the first 2–3 weeks, patients resumed activities progressively,	Recurrence, postoperative complications, pain, active forward elevation	1, 3 months	19/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
		Age range: 18-65 years		provided that they did not trigger pain. Patients were instructed to perform self-rehabilitation exercises at home, as of the first postoperative day. Return to sports and strengthening exercises were permitted under the supervision of a physiotherapist after 3 months. All patients were instructed to perform each exercise five times per day Control: -	ROM, Passive forward elevation ROM, external and internal rotation ROM.		
Shah et al, 2018	22		Observational	Sling immobilization, AAROM commenced immediately post-operatively, closed chain isometric exercises of the shoulder.Progression to AROM per patient	Constant score, Oxford score, Recurrent instability	2 years	

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
				comfort (usually within 4 weeks). Open chain exercises and light resistance training. Sports specific rehabilitation program. Sports specific exercises for rugby with safe progression. Simulated falling and drop-bag tackling at 75-80% of unaffected side. Return to play permitted when strength was at least 80% of the pre-injury level.			
Shih et al, 2011	64	Non-operative treatment: n=25 Acute arthroscopic repair: n=39 Average age: 22 years (Range: 17-29 years)	Prospective non-randomized	Sling immobilization, pendulum exercises, active elbow exercises for the first 4 weeks. 4-8 weeks: Single plane shoulder movements, vertical arm elevation, IR, ER with arm adducted.	WOSI, DASH, ROM, Return to active duty	71 months (range: 60-84 months)	

Table S2:

Authors	Sample Size	Population	Study design	Intervention	Outcomes	Follow-up	Downs and Black Score
				Week 8: Multiplanar movements, abduction with external rotation. Week 12: Aggressive exercise program. 6 months: Full participation in throwing sports			
Stein et al, 2015	54	Primary Bankart group(n=27): 23 males, 4 females Mean age±SD: 26.6±9.8 years Radiographic control(n=27): 23 males, 4 females	Prospective longitudinal	0-4 weeks, the abduction was limited to 60 degrees Between the 2nd and 3rd month, use of the sling was reduced to nights only and abduction allowed up to 90 in IR with high external rotation up to 20 in 90 abduction (hER). Muscular strength and coordinative rehabilitation were intensified. Endurance	Functional shoulder exam, Musculotendinous assessments with MRI for the rotator cuff muscles,	12-18 months [average 14.8±5.4]	21/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
		Mean age±SD: 29.4±7 years		training was permitted from the 3rd month. From the 4th to 6th month Return-to-play exercises for the reintegration of the sensorimotor system (proprioception and kinesthesia) 6th month, stressful exercises for the anteroinferior capsule labrum- resumption of the previous shoulder sport was allowed (shoulder sport phase). Control: Primary Bankart group vs Radiographic control group			
Sung et al, 2015	30	Experimental group(n=15) : Mean age ± SD: 59.73±6.09 years	Experimental	Control group: 20 minutes of interferential current therapy, 10 minutes of	Active, passive shoulder flexion and abduction	Not specified	14/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
		Control group(n=15): Mean age ± SD: 59.73±6.09 years		ultrasound therapy, heat therapy for 20 minutes, TENS for 10 minutes, laser therapy for 10 minutes Experimental group: In addition to the control treatment, the experimental group received physical therapy that focused on shoulder stabilization exercises to strengthen shoulder retractors, adductors and external rotators.	ROM, VAS, CMS.		
Szabo et al, 2021	20	Experimental: N=10 Kinetic Recovery: N=10 Age range: 34 to 71 years	case study	KINETIC RECOVERY PROGRAM: We applied for this program, for three weeks, with the objectives of: – In the first week: Fighting pain; Reducing inflammation;	active and passive spectrum of movement assessment, muscle strength assessment, visual analogy scale, Shoulder Pain and Disability Index (SPADI).	3 weeks	12/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				Protection of the spotted tissue and sustaining the flexibility of the proximate and outer joints. – In the second week: Improving joint mobility; Improving muscle tone, and Improving the muscular strength of the entire affected limb. – In the third week: Improving proprioception; Improving neuromuscular control and maintaining the strength level. HYDROKINETIC RECOVERY PROGRAM same objectives as above			
Terra et al, 2019	53	Mean age ± SD: 30.9±8.20 years	Case series	Patients wore a sling full-time for 3 weeks and partially for	Rowe score,VAS pain score, Relationship	27 months	23/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
		Age range: 18-40 years Median age: 29 years		3 weeks. After the first 3 weeks, controlled passive movements were initiated as well as exercises of scapular control. After week 8, patients began active exercises, and after week 12, they initiated exercises of strengthening and stretching.1,27 Sporting gesture training and prelesion conditioning programs were initiated within 3 months. Athletes were permitted to return to regular practice after 5 to 6 months.	between surgical outcomes and age or level of sports activity, Complications related to a neurological injury or deep infection.		
Uhring et al, 2014	31	Surgical treatment (n=14): 11 males, 3 females	Non-randomized prospective	After 4 weeks' immobilization in internal rotation, all patients	recurrence or subluxation	`1,2,3,6 months, 1 year, 2 years	17/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
		Mean age: 20.6 years Age range: 15-28 years. Non-operative treatment (n=17): 15 males, 2 females Mean age: 21.7 years Age range: 16-29 years.		(whether managed non-operatively or surgically) underwent the same rehabilitation program: • week 4: ◦ passive exercises to recover ranges of motion, ◦ active mobilization, ◦ no external rotation or return to play, ◦ return to work; • week 8: ◦ passive exercises to recover ranges of motion, ◦ unrestricted active mobilization, ◦ muscle chain reinforcement and balance; • for non-operated patients: return to play at 2 months; • for operated patients:	clinical examination, postoperative functional scores		

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				◦ month 3: return to play without contact or overhead movement; ◦ month 4: unrestricted return to play. Control: Emergency stabilization group vs non-operative group			
Valentin et al, 1998	15	Median age: 23 years Age range: 17-34 years	Prospective	Immobilization for four weeks. Pendulum exercises with the elbow extended, allowing passive flexion, and passive abduction of the shoulder to 45", and 30", respectively. After four weeks the ROM was gradually regained, and after eight weeks strengthening exercises were introduced. The patients returned to sports after five to six months Control: -	Instability, activity level, Pain on VAS, Strength, ROM, Rowe score, complications.	18 months [Range: 10-33 months].	16/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
Voos et al, 2010	73	61 males, 12 females Mean age: 33 years Age range: 15-55 years	Case series	Patients wore an immobilizer at all times when not exercising. At 4 weeks the immobilizer was discontinued and active-assisted range of motion was progressed in forward flexion and external rotation. From weeks 6 to 12, gradual strengthening was added. At 12 weeks, upper extremity flexibility and strengthening continued. Plyometrics, closed-chain strengthening, and proprioceptive exercises were initiated. Sports or activity-related programs began and progressed.	Operative findings, physical examinations, complications, ASES	33 months (Range: 24-49 months)	22/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
				Patients were allowed to return to their sport without restrictions at 5 to 6 months postoperatively. Control: -			
Weng et al, 2009	9	7 males, 2 females Mean age±SD: 34.55±17.12 years	Case series	Immobilization in an abduction sling for the 1st postoperative week, after which the sling was removed. 2 weeks, forward flexion was limited to 90°, external rotation was limited to neutral, and pendulum exercises were performed. 4 weeks: resume AROM, strength training, and progress daily activities. Control: Preoperative vs Postoperative	Rowe score, redislocation	4.5 years (range: 4.5-14 years, mean: 7.5)	13/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
Wheeler et al	47	Non-operative(n=38): 37 males, 1 female Mean age: 18.5 years Age range: 17-22 years Arthroscopic treatment (n=9): 9 males Mean age: 19 years Age range: 18-21years	Retrospective review	3 weeks of immobilization, supervised physical therapy, No contact/ overhead sports for 3 months. Control: Non-operative vs Arthroscopic	Recurrence rate	14 months	9/28
Wintzell et al, 1999	15	Arthroscopy group (n=15): 13 males, 2 females Mean age±SD: 24±3.4 years	Prospective controlled	Immobilization in a sling to prevent abduction and external rotation. The rehabilitation protocol was tailored to each patient and was closely supervised. The arm was placed in a swath for three weeks and	Recurrence rate, Lysholm score, ROM.	1, 6 and 12 months	10/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
		Control group (n=15): 13 males, 2 females Mean age±SD: 24.2±3.7 years		external rotation was not permitted. During the first four weeks passive range of motion exercises were performed along with isometric exercises for abduction/adduction and flexion/extension. From week 4 the range of permitted motion was increased excluding external rotation, which was initiated after week 8. Participation in sporting activities was allowed six months after the surgery. Control: Acute arthroscopic lavage vs Traditional non-surgical therapy.			
Wintzell et al (b), 1999	30	Age range: 18-30 years	Prospective randomized	Optional sling, free movement of the affected shoulder.	Rowe score, Constant Murley score,	2 years	12/28

Table S2:

Authors	**Sample Size**	**Population**	**Study design**	**Intervention**	**Outcomes**	**Follow-up**	**Downs and Black Score**
		Lavage group: n=15, Non-operative group: n=15			Apprehension test, Return to work		
Yiannakopoulos et al, 2006	18	Mean age: 22.4 years (Range: 19-27 years). All were male skiers	Case series	Immobilization in a swath for 3 weeks. PROM exercises commenced at week 4, isometric abduction/adduction, flexion/extension. External rotation initiated at week 8. Return to sporting activities permitted at 6 months.	ROM, Apprehension sign, Relocation test, Rowe score	6 weeks, 3,12,24 months	17/28

Table S3: GRADE Assessment

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**post-surgical EBI**	**EBI alone**	**Relative (95% CI)**	**Absolute (95% CI)**		
Non-Recurrence (follow-up: range 3 months to 5 years)												
4	observational studies	very serious[a]	serious[b]	not serious	not serious		122/216 (56.5%)	94/216 (43.5%)	**RR 2.03** (1.03 to 3.97)	**448 more per 1,000** (from 13 more to 1,000 more)	Low	
Return to Activity (follow-up: range 3 months to 5 years)												
3	observational studies	very serious[c]	serious[d]	not serious	not serious		104/143 (72.7%)	39/143 (27.3%)	**RR 1.81** (0.96 to 3.43)	**-- per 1,000** (from -- to --)	Low	

CI: confidence interval; **RR:** risk ratio; **SMD:** standardised mean difference

Explanations

a. Average quality appraisal score of 9.7

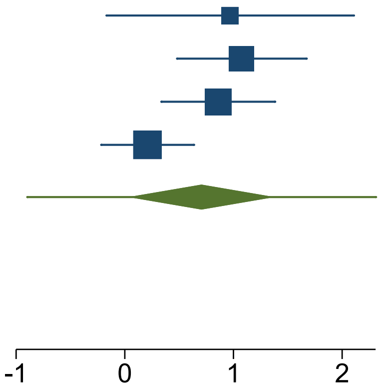
b. Heterogeneity score of 50.3

c. Risk of bias score of 9.5

d. Heterogeneity score of 63.9

Non-Recurrence of ASD

Study	Surgical + EBI Yes	Surgical + EBI No	EBI Yes	EBI No	Log Risk Ratio with 95% CI	Weight (%)
DeBerardino et al. [39]	43	6	2	4	0.97 [-0.17, 2.10]	11.15
Gigis et al. [38]	33	5	8	19	1.08 [0.48, 1.67]	25.79
Khan et al. [37]	24	2	9	14	0.86 [0.34, 1.38]	29.09
Wheeler et al. [23]	7	2	24	14	0.21 [-0.22, 0.63]	33.98
Overall					0.71 [0.03, 1.38]	

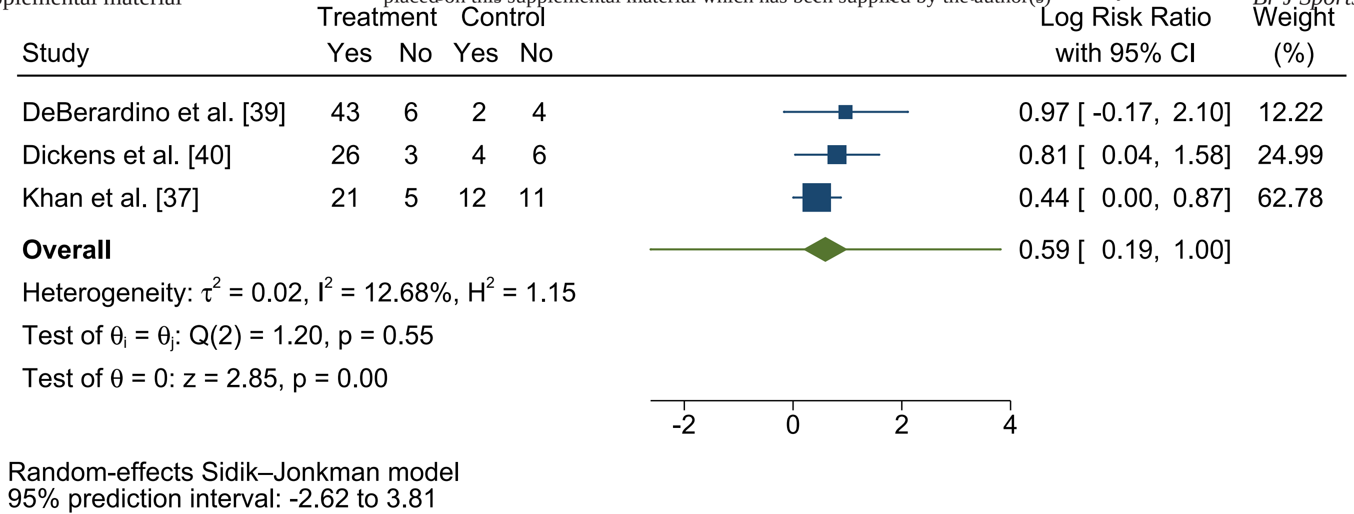


Heterogeneity: $\tau^2 = 0.09$, $I^2 = 51.17\%$, $H^2 = 2.05$

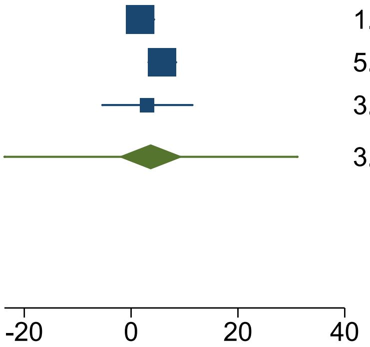
Test of $\theta_i = \theta_j$: $Q(3) = 7.01$, $p = 0.07$

Test of $\theta = 0$: $t(3) = 3.34$, $p = 0.04$

Random-effects Sidik–Jonkman model
Knapp–Hartung standard errors
95% prediction interval: -0.897 to 2.308


Treatment
Control
Log Risk Ratio with 95% CI
Weight (%)
Study
Yes
No
Yes
No
DeBerardino et al. [39] 43 6 2 4 0.97 [-0.17, 2.10] 12.22
Dickens et al. [40] 26 3 4 6 0.81 [0.04, 1.58] 24.99
Khan et al. [37] 21 5 12 11 0.44 [0.00, 0.87] 62.78
Overall 0.59 [0.19, 1.00]
Heterogeneity: τ² = 0.02, I² = 12.68%, H² = 1.15
Test of θi = θj: Q(2) = 1.20, p = 0.55
Test of θ = 0: z = 2.85, p = 0.00
-2
0
2
4
Random-effects Sidik–Jonkman model
95% prediction interval: -2.62 to 3.81

Study	Surgical + EBI N	Surgical + EBI Mean	Surgical + EBI SD	EBI N	EBI Mean	EBI SD	Mean Difference with 95% CI	Weight (%)
Gigis et al. 2013 [38] Rowe Score	38	30.9	5.29	27	29.2	4.78	1.70 [-0.81, 4.21]	45.43
Sung et al. 2015 [41] CMS	15	14.8	3.40	15	9.00	3.66	5.80 [3.27, 8.33]	45.16
Multanen et al. 2020 [42] ASES	23	16.0	15.1	22	13.0	13.6	3.00 [-5.39, 11.39]	9.41
Overall							3.67 [-2.30, 9.65]	



Heterogeneity: $\tau^2 = 2.72$, $I^2 = 48.22\%$, $H^2 = 1.93$

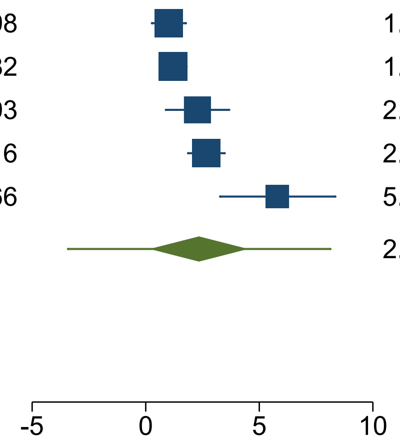
Test of $\theta_i = \theta_j$: $Q(2) = 5.12$, $p = 0.08$

Test of $\theta = 0$: $t(2) = 2.65$, $p = 0.12$

Random-effects Sidik–Jonkman model
Knapp–Hartung standard errors
95% prediction interval: -23.72 to 31.07

CMS Specific Subscales

Study	Surgical + EBI N	Surgical + EBI Mean	Surgical + EBI SD	EBI N	EBI Mean	EBI SD	Mean Difference with 95% CI	Weight (%)
Sung et al. 2015 [41] CMS Pain	15	2.34	1.08	15	1.33	0.98	1.01 [0.27, 1.75]	21.98
Sung et al. 2015 [41] CMS Function	15	2.80	0.81	15	1.60	0.82	1.20 [0.62, 1.78]	22.41
Sung et al. 2015 [41] CMS ROM	15	4.67	1.94	15	2.40	1.93	2.27 [0.88, 3.66]	19.51
Sung et al. 2015 [41] CMS Strength	15	4.26	1.07	15	1.60	1.16	2.66 [1.86, 3.46]	21.81
Sung et al. 2015 [41] CMS Total	15	14.8	3.40	15	9.00	3.66	5.80 [3.27, 8.33]	14.29
Overall							2.34 [0.19, 4.50]	



Heterogeneity: $\tau^2 = 2.68$, $I^2 = 92.67\%$, $H^2 = 13.64$

Test of $\theta_i = \theta_j$: Q(4) = 22.45, p = 0.00

Test of $\theta = 0$: t(4) = 3.02, p = 0.04

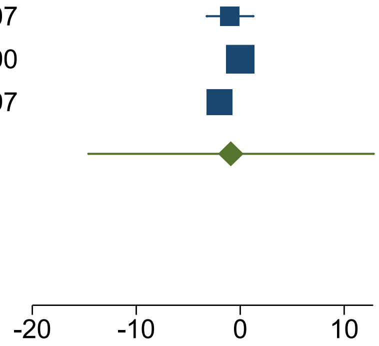
Random-effects Sidik–Jonkman model
Knapp–Hartung standard errors
95% prediction interval: -3.42 to 8.11

Study	Surgical + EBI N	Surgical + EBI Mean	Surgical + EBI SD	EBI N	EBI Mean	EBI SD	Mean Difference with 95% CI	Weight (%)
Multanen et al. 2020 [42] Grip Strength	23	2.00	3.54	22	3.00	4.07	-1.00 [-3.23, 1.23]	18.84
Multanen et al. 2020 [42] Ext Rot Strength	23	2.00	1.04	22	2.00	0.90	0.00 [-0.57, 0.57]	45.29
Multanen et al. 2020 [42] Int Rot Strength	23	2.00	1.77	22	4.00	1.97	-2.00 [-3.09, -0.91]	35.87
Overall							-0.91 [-2.13, 0.32]	

Heterogeneity: $\tau^2 = 0.77$, $I^2 = 70.86\%$, $H^2 = 3.43$

Test of $\theta_i = \theta_j$: Q(2) = 10.36, p = 0.01

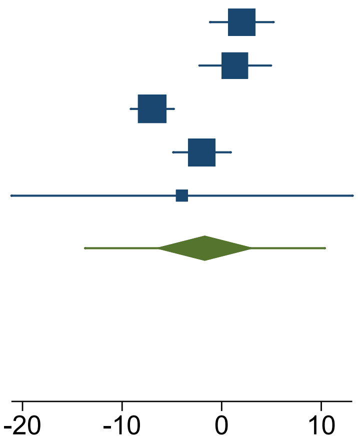
Test of $\theta = 0$: z = -1.45, p = 0.15



Random-effects Sidik–Jonkman model
95% prediction interval: -14.61 to 12.79

AROM Measures

Study	Surgical + EBI N	Surgical + EBI Mean	Surgical + EBI SD	EBI N	EBI Mean	EBI SD	Mean Difference with 95% CI	Weight (%)
Multanen et al. 2020 [42] FF AROM	22	23.0	5.69	22	21.0	5.03	2.00 [-1.17, 5.17]	23.47
Sung et al. 2015 [41] FF AROM	15	9.34	4.51	15	8.00	5.44	1.34 [-2.24, 4.92]	22.32
Sung et al. 2015 [41] Abd AROM	15	9.67	2.41	15	16.7	3.48	-6.99 [-9.13, -4.85]	26.21
Multanen et al. 2020 [42] Ext Rot AROM	22	23.0	5.02	22	25.0	4.70	-2.00 [-4.87, 0.87]	24.32
Multanen et al. 2020 [42] Int Rot AROM	22	106.0	29.1	22	110.0	28.8	-4.00 [-21.11, 13.11]	3.68
Overall							-1.70 [-6.67, 3.27]	



Heterogeneity: $\tau^2 = 11.07$, $I^2 = 79.71\%$, $H^2 = 4.93$

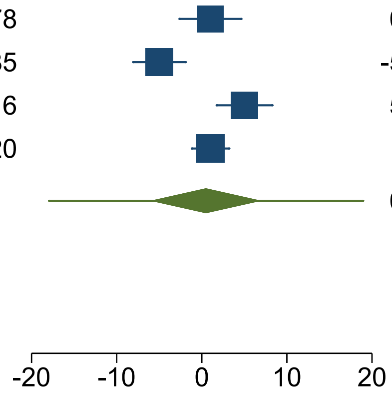
Test of $\theta_i = \theta_j$: Q(4) = 28.95, p = 0.00

Test of $\theta = 0$: t(4) = -0.95, p = 0.40

Random-effects Sidik–Jonkman model
Knapp–Hartung standard errors
95% prediction interval: -13.72 to 10.32

PROM Measures

Study	Surgical + EBI N	Surgical + EBI Mean	Surgical + EBI SD	EBI N	EBI Mean	EBI SD	Mean Difference with 95% CI	Weight (%)
Sung et al. 2015 [41] FF PROM	15	9.66	4.21	15	8.67	5.78	0.99 [-2.63, 4.61]	23.60
Sung et al. 2015 [41] Abd PROM	15	3.00	3.65	15	8.00	4.85	-5.00 [-8.07, -1.93]	24.96
Multanen et al. 2020 [42] Ext Rot PROM	23	35.0	5.84	22	30.0	5.16	5.00 [1.74, 8.26]	24.51
Multanen et al. 2020 [42] Int Rot PROM	23	9.00	4.13	22	8.00	3.20	1.00 [-1.18, 3.18]	26.93
Overall							0.48 [-6.05, 7.01]	



Heterogeneity: $\tau^2 = 14.14$, $I^2 = 86.12\%$, $H^2 = 7.20$

Test of $\theta_i = \theta_j$: Q(3) = 19.91, p = 0.00

Test of $\theta = 0$: t(3) = 0.23, p = 0.83

Random-effects Sidik–Jonkman model
Knapp–Hartung standard errors
95% prediction interval: -18.00 to 18.91